Installation, Setup and Operation

INSTRUCTIONS

for

SUNNEN® PRECISION HONING MACHINE

Model: SSH-1680

READ THE FOLLOWING INSTRUCTIONS THOROUGHLY AND CAREFULLY BEFORE UNPACKING, INSPECTING, OR INSTALLING THE SUNNEN® PRECISION HONING MACHINE.

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SUNNEN® PRODUCTS COMPANY • 7910 MANCHESTER ROAD • ST. LOUIS, MO 63143, U.S.A. • PHONE: 314-781-2100

GENERAL INFORMATION

The Sunnen® equipment has been designed and engineered for a wide variety of parts within the capacity and limitation of the equipment. With proper care and maintenance this equipment will give years of service.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY AND THOROUGHLY BEFORE UNPACKING, INSPECTING, OR INSTALLING THIS EQUIPMENT.

IMPORTANT: Read any supplemental instructions BEFORE installing this equipment. These supplemental instructions give you important information to assist you with the planning and installation of your SUNNEN® equipment.

Sunnen Technical Service Department is available to provide telephone assistance for installation, programming, & troubleshooting of your Sunnen equipment. All support is available during normal business hours, 8:00 AM to 4:30 PM Central Time.

Review all literature provided with your Sunnen equipment. This literature provides valuable information for proper installation, operation, and maintenance of your equipment. Troubleshooting information can also be found within the Instructions. If you cannot find what you need, call for technical support.

Where applicable, programming information for your Sunnen equipment is also included. Most answers can be found in the literature packaged with your equipment.

Help us help you. When ordering parts, requesting information, or technical assistance about your equipment, please have the following information available:

- Have ALL MANUALS on hand. The Customer Services Representative or Technician will refer to it.
- Have Model Number and Serial Number printed on your equipment Specification Nameplate.
- Where Applicable: Have Drive model and all nameplate data. Motor type, brand, and all nameplate data.

For Troubleshooting, additional information may be required:

- Power distribution information (type - delta, wye, power factor correction; other major switching devices used, voltage fluctuations)
- Installation Wiring (separation of power & control wire; wire type/class used, distance between drive and motor, grounding).
- Use of any optional devices/equipment between the Drive & motor (output chokes, etc.).

For fast service on your orders call:

Sunnen Automotive Customer Service toll free at: 1-800-772-2878

Sunnen Industrial Customer Service toll free at: 1-800-325-3670

Customers outside the USA, contact your local authorized Sunnen Distributor.

Additional information available at: http://www.sunnen.com or e-mail: sunnen@sunnen.com

NOTE: Sunnen reserves the right to change or revise specifications and product design in connection with any feature of our products contained herein. Such changes do not entitle the buyer to corresponding changes, improvements, additions, or replacements for equipment, supplies or accessories previously sold. Information contained herein is considered to be accurate based on available information at the time of printing. Should any discrepancy of information arise, Sunnen recommends that user verify the discrepancy with Sunnen before proceeding.

ESD PREVENTION REVIEW

Let's review the basics of a sound static control system and its effective implementation. First, in the three step plan:

1. Always ground yourself when handling sensitive components or assemblies.
2. Always use a conductive or shielded container during storage or transportation. These materials create a Faraday cage which will isolate the contents from static charges.
3. Open ESD safe containers only at a static safe work station.

At the static safe work station, follow these procedures before beginning any work:

A. Put on your wrist strap or foot grounding devices.

B. Check all grounding cords to make sure they are properly connected to ground, ensuring the effective dissipation of static charges.

C. Make sure that your work surface is clean and clear of unnecessary materials, particularly common plastics.

D. Anti-static bubble wrap has been included for use at the machine when an ESD safe workstation is not available.

You are now properly grounded and ready to begin work. Following these few simple rules and using a little common sense will go a long way toward helping you and your company in the battle against the hazards of static electricity. When you are working with ESD sensitive devices, make sure you:

GROUND

ISOLATE

NEUTRALIZE

SUNNEN® LIMITED PRODUCT WARRANTY

SUNNEN® Products Company and its subsidiaries (SPC) warrant that all new SPC honing machines, gaging equipment, tooling, and related equipment will be free of defects in material and/or workmanship for a period of one year from the date of original shipment from SPC.

Upon prompt notification of a defect during the one-year period, SPC will repair, replace, or refund the purchase price, with respect to parts that prove to be defective (as defined above). Any equipment or tooling which is found to be defective from improper use will be returned at the customer's cost or repaired (if possible) at customer's request. Customer shall be charged current rates for all such repair.

Prior to returning any SPC product, an authorization (RMA#) and shipping instructions must be obtained from the Customer Service Department or items sent to SPC will be returned to the customer.

Warranty Limitations and Exclusions This Warranty does not apply to the following:

- Normal maintenance items subject to wear and tear: (belts, fuses, filters, etc).
- Damages resulting from but not limited to:
  - › Shipment to the customer (for items delivered to customer or customer's agent F.O.B., Shipping Point)
  - › Incorrect installation including improper lifting, dropping and/or placement
  - › Incorrect electric power (beyond +/- 10% of rated voltage) including intermittent or random voltage spikes or drops
  - › Incorrect air supply volume and/or pressure and/or contaminated air supply
  - › Electromagnetic or radio frequency interference from surrounding equipment (EMI, RFI)
  - › Storm, lightning, flood or fire damage
  - › Failure to perform regular maintenance as outlined in SPC manuals
  - › Improper machine setup or operation causing a crash to occur
  - › Misapplication of the equipment
  - › Use of non-SPC machines, tooling, abrasive, fixturing, coolant, repair parts, or filtration
  - › Incorrect software installation and/or misuse
  - › Non-authorized customer installed electronics and/or software
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Shipping Damages

Except in the case of F.O.B., Buyer's destination shipments, SPC will not be liable for any settlement claims for obvious and/or concealed shipping damages. The customer bears the responsibility to unpack all shipments immediately and inspect for damage. When obvious and/or concealed damage is found, the customer must immediately notify the carrier's agent to make an inspection and file a claim. The customer should retain the shipping container and packing material.

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Any alteration or reverse engineering of the software is expressly forbidden and is in violation of this agreement.

SPC reserves the right to update the software covered by this agreement at any time without prior notice and any such updates are covered by this agreement.

SAFETY INSTRUCTIONS

READ FIRST

This machine, like any equipment, may be dangerous if used improperly. Please read all warnings and instructions before attempting to use this machine.

Always disconnect power at main enclosure before servicing machine.[1]

Always wear eye protection when operating this machine.

WARNING: Do not wear cotton or heavy gloves while operating this equipment! If gloves must be worn, wear only the tear-away type.

NEVER open or remove any machine cover or protective guard with power "ON." Always disconnect power at main enclosure before servicing this equipment.[1]

DO NOT attempt any repair or maintenance procedure beyond those described in this book. Contact your Sunnen Field Service Engineer or Technical Services Representative for repairs not covered in these instructions.

Due to the wide variety of machine configurations, all possibilities cannot be described in these instructions. Instructions for safe use and maintenance of optional equipment ordered through Sunnen, will be provided through separate documentation and/or training provided by your Sunnen Field Service Engineer or Technical Services Representative.

DO NOT attempt to defeat any safety device on this machine or on any of the optional equipment.

If specially built automation components are added to this system, be sure that safety is not compromised. If necessary, obtain special enlarged work area safety system from Sunnen Products Co.

[1] DO NOT touch electrical components until main input power has been turned off and *CHARGE* lamps are extinguished. WARNING: The capacitors are still charged and can be quite dangerous, after power has been turned off.

IMPORTANT NOTE

The temperature requirements of Sunnen® Precision Honing Machines, equipped with electronic components, have been established as 35 degrees C (95 degrees F). Above this temperature, an optional cooler will be available to handle temperatures from 35º to 46º C (95º to 115º F). IT IS NOT recommended that Machine, equipped with electronic components, be operated at temperatures above 46º C (115º F). Sunnen Products Company warrants Machine, equipped with electronic components, for operating environments up to 35ºC (95º F). For operating environments of 35º to 46º C (95º to 115º F) the warranty only applies if the optional cooler is installed on Machine, equipped with electronic components. No warranty coverage is offered for operating environments above 46º C (115º F).

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INTRODUCTION

This Instruction Manual is provided to give the information required to install and operated the Sunnen® Precision Honing Machine.

The SSH-1680 Precision Honing Machine is to be used for finishing bores in small workpieces. In finishing bores, this machine can achieve any or all of the following results: fast stock removal, consistent final size, a high degree of cylindricity, fine surface finish.

As there are numerous workpieces which can be honed on this machine, all the possible combinations cannot be discussed here. The determining factor as to whether a particular part or material can be honed in the machine will come with experience from working with the machine in your shop.

When ordering parts for, or requesting information about your machine, include the serial number of your machine.

READ THE FOLLOWING INSTRUCTIONS THOROUGHLY BEFORE UNPACKING, INSPECTING, OR INSTALLING THE PRECISION HONING MACHINE.

GENERAL INFORMATION

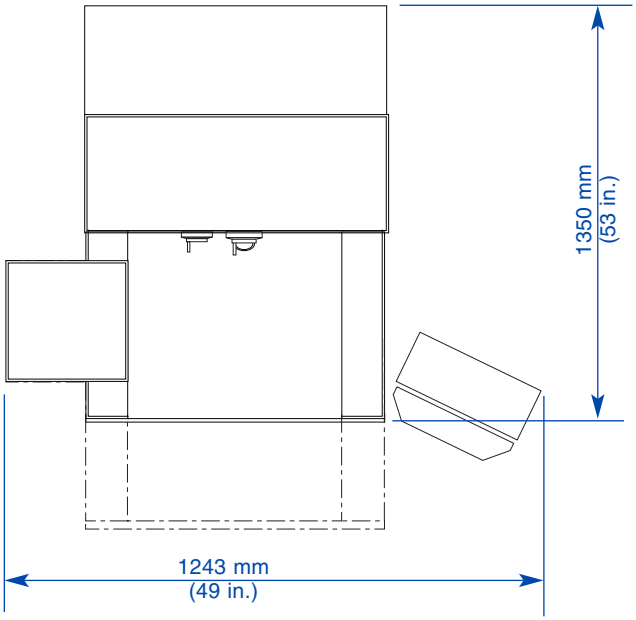
Honing is a machining process for precision bore sizing and finishing. Because the Stone(s) touches most of the part surface during honing, the relative speed and pressure between the stones and work piece are less than those of grinding; and the temperatures are lower. Honing produces greater accuracy and a finer surface finish than grinding in mass production. Honing will create no surface stress. Honing is also a good means of high efficiency for the high precision bores, thin long bores and blind bores. With the development of high performance abrasives and high efficiency automatic honing machine tools, the applications for honing, as a machining process, have been widely increased.

GENERAL INFORMATION & SPECIFICATIONS

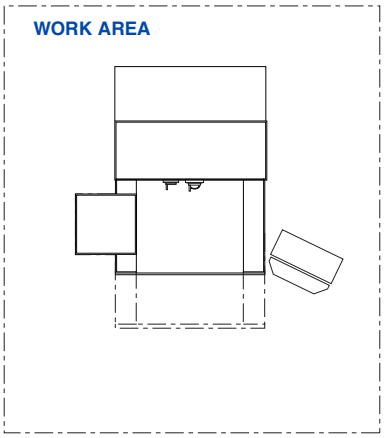
Sunnen® Precision Honing Machine - Model SSH-1680

Diameter Range (ID):[1]-	3 to 60 mm (.118 - 2.36 in.)
Spindle Speeds:	250 - 2500 rpm (Variable Speed Adjustment)
Spindle Motor:	1,5 kw (2 hp), 0-200 Hz
Stroke Motor:	0.75 kw (1 hp), 10-200 Hz Motor
Stroke Speeds:	80 - 310 n/m
Stroke Length:	0 - 160 mm
Brake of Spindle and Stroke:	Electro-Type Brake
Coolant Pump Motor:	0,125 kw (0.17 hp)
Coolant Capacity:	96 liters (25 gallons)
Coolant Requirements:	Sunnen Industrial Honing Fluids
Floor Space:	1350 D x 1243 W x 1358 H mm (53 x 49 x 53.4 in.) (with work light 1570mm)
Floor Weight:	720 kg (1587 lbs)
Electrical Requirements:	230V, 60Hz, 3pH; 380V, 50Hz, 3pH; 380V, 60Hz, 3pH
Color:	Pearl Gray / Pewter Gray / Black Trim
Noise Emission:	Less than 70 dB(A) continuous Load (max. noise) condition in a typical factory environment.

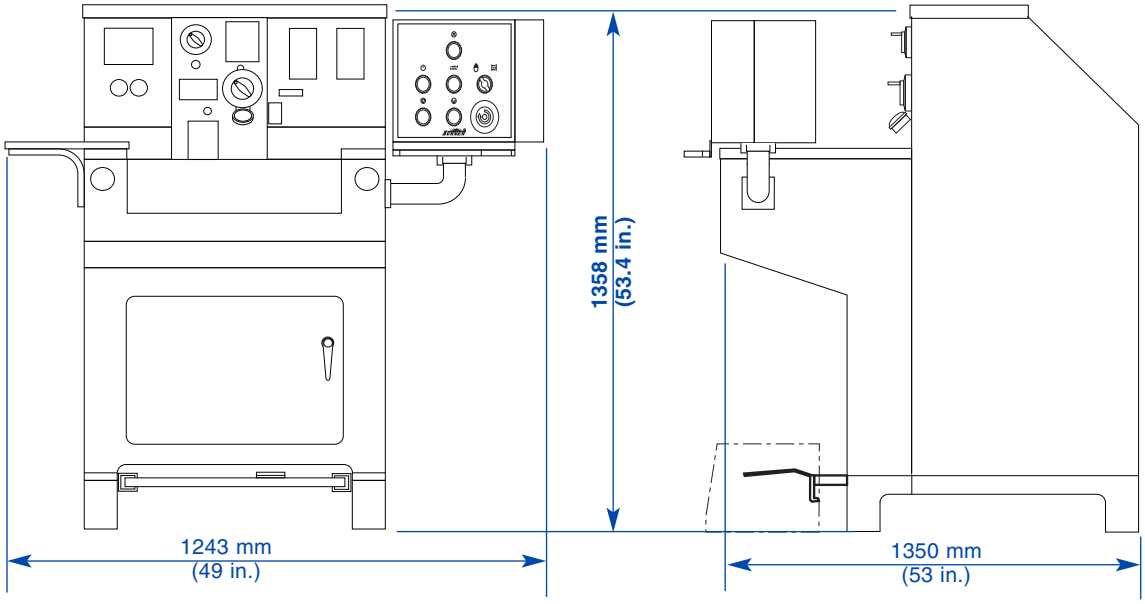
[1] Diameter range, length range, and workpiece weight are contingent on workpiece and application.



TOP VIEW



Floor Weight:
Approximately 720 kg. (1587 lbs.) including coolant.



FRONT VIEW

SIDE VIEW

SECTION 1
INSTALLATION

PURPOSE

Consult this section when unpacking, inspecting, and installing Sunnen® SSH-1680 Precision Honing Machine. Hereafter, referred to as the Machine (see Figure 1-1).

FIGURE 1-1, Precision Honing Machine

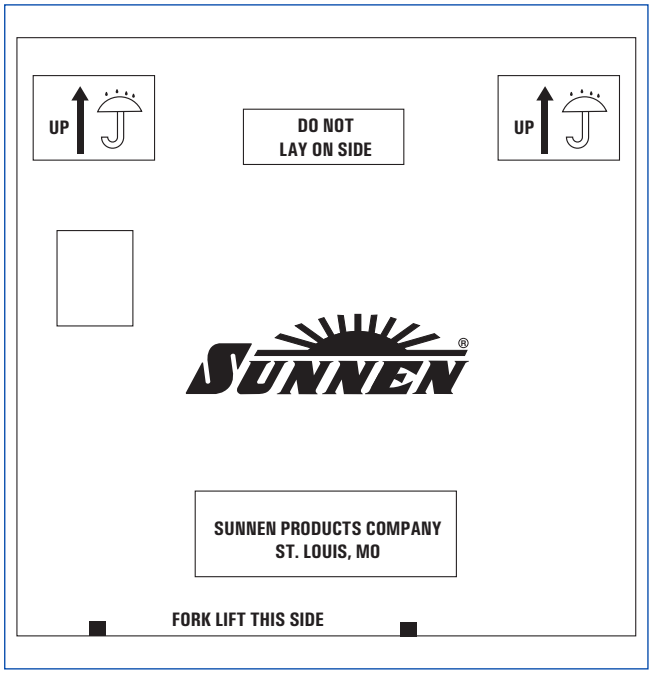


FIGURE 1-2, Unpacking

TOOLS & MATERIALS

The following tools and materials are required for unpacking and installing machine:

Wire Cutters/Strippers	Knife
Screw Driver (Std. nose)	Hammer
Slip-Joint Pliers	Crow Bar
Open End Wrenches	Tin Strips
Cleaning Solvent	Hex Wrenches

UNPACKING & INSTALLATION

Read the following instructions carefully and thoroughly before unpacking, inspecting and installing your Machine. All references to right and left in these instructions are, unless otherwise noted, as seen by operator as one looks at front of Machine or assembly being described (refer to Figure 1-1).

UNPACKING

1. Refer to instructions on side of shipping carton for lifting when unloading Machine.

As the center of gravity of the shipping pallet leans to one side, the two fork arms of the forklift must fork under the shipping pallet on the side shown on the machine box (see Figure 1-2). In this way, you can lift the machine steadily and remove it from the truck.

2. Remove the waterproof wrapping from box.

3. Remove top and front of shipping carton by cutting along edges.

4. Remove Components shipped inside carton. Then unbolt and remove Machine from carton.

5. Inspect Machine and Components for dents, scratches, or damage resulting from improper handling, by carrier. If damage is evident, immediately file a claim with carrier.

INSTALLATION

6. Move Machine to desired location.

Using a forklift carefully move the machine to desired installation location and lower into place. When using a crane, you should be sure that the crane steel wire cannot push down on the machine cover and the aluminum alloy double rail work table otherwise the machine may be damaged.

7. Remove and discard cardboard packing.

8. Level Machine:
Installing the machine does require the concrete floor to be flat but does not require the use of foot screws to fix to the floor, but the 4 feet of the machine must be firmly on the floor leveled side to side. Lean the machine 1° to the front, by adjusting two (2) screws (M16) at the back of the machine. This is to ensure coolant doesn't flow into the spindle while running; and to keep the machine's base stable.

9. Remove four (4) Screws and remove cover from back of base. Pull Coolant Cart out from behind the base (see Figure 1-3).

10. Clean inside of Coolant Cart; then pour approximately 90 liters (23 gallons) of Sunnen industrial honing or HM-18 honing oil into cart.

11. Push Coolant Cart back under Machine base and reinstall cover, using four (4) screws.

12. Install oil pipe and connect pump motor power plug.

NOTE: The pedal assembly movement up and down should not interfere with Coolant Cart and trundle.

13. Install Work Tray and place tray pads in tray (see Figure 1-4).

14. Install Side Guards (see Figure 1-5).

15. Install work light.

ELECTRICAL CONNECTION

1. Connect Machine to the power source (3ph, 380V, 50Hz) or (3ph, 230V, 60Hz), depending on unit ordered (see Figure 1-6).

2. Connect the ground cord to earth ground terminal.

OPERATIONAL CHECK

Read Section 2 and 3 thoroughly and carefully before performing Operational Check.

1. Turn ON power at Main Power Disconnect.

2. Direct Coolant Nozzles downward, toward anti-splash pad.

3. Push Power ON Button to start Coolant Pump Motor. Wait a few seconds for coolant pressure to build up.

4. With Coolant Nozzles directed downward; turn two individual coolant nozzle control valves on coolant manifold on; coolant can be seen coming out of the nozzle.

If coolant cannot be seen or the coolant flow is little, the coolant line may be clogged, then you should check and clean the line; or possibly the rotation of the pump motor is incorrect, then exchange two wires of the power source to change the rotation of the pump motor.

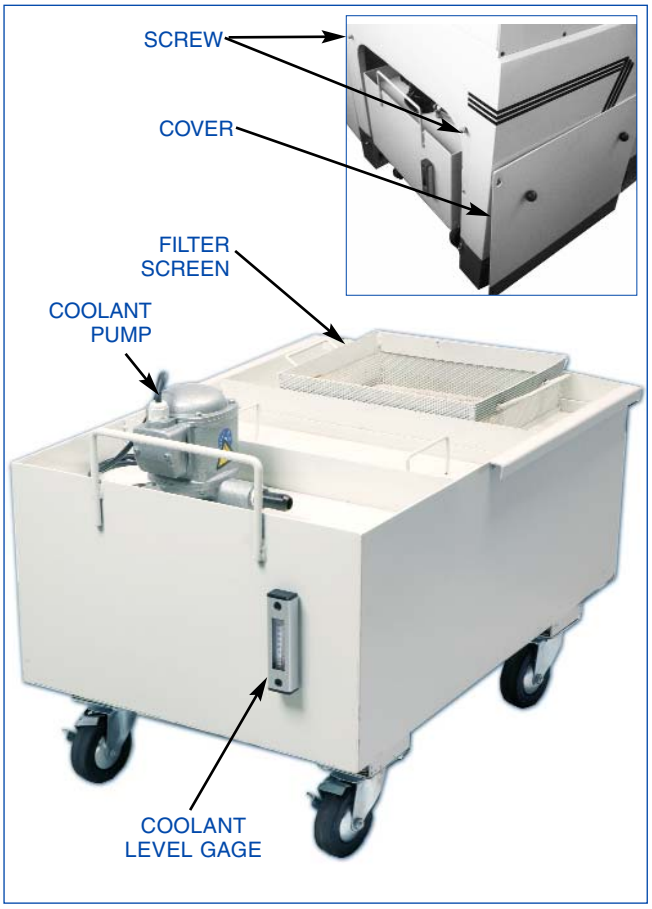


FIGURE 1-3, Coolant Cart

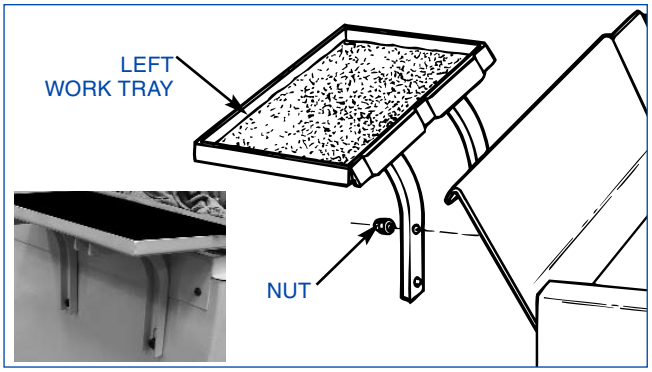


FIGURE 1-4, Work Tray

FIGURE 1-5, Side Guards

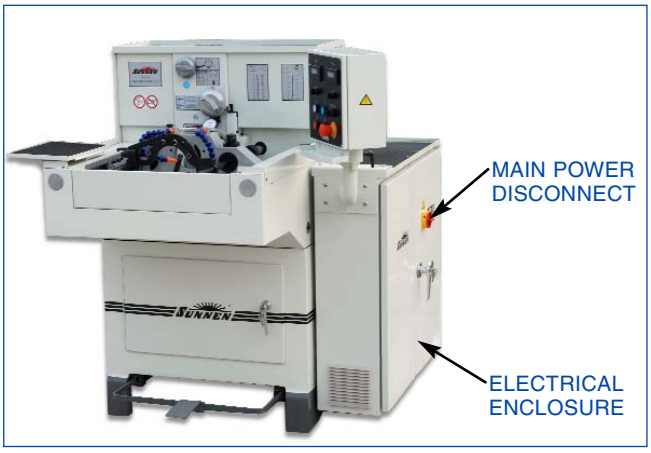


FIGURE 1-6 Electrical Control Enclosure

6. Push STOP Button.

7. Turn OFF power at Main Power Disconnect.

8. Close two Individual Coolant Valves on Flow Control Manifold.

OPTIONAL LIGHT CURTAIN

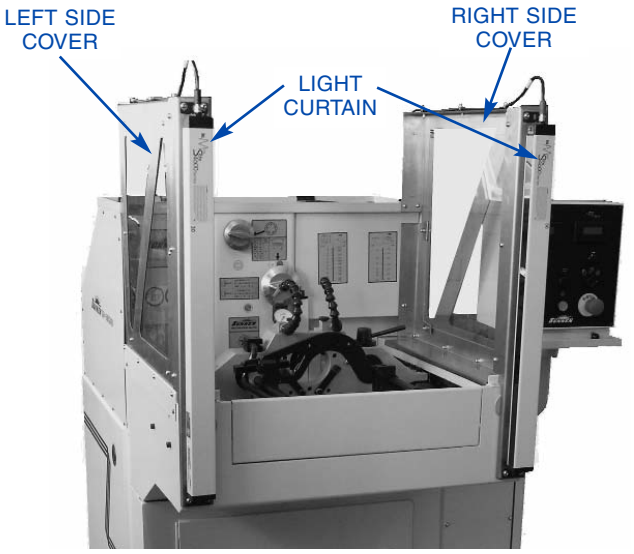
(CE Machines Only) CE machines come with optional Light Curtain and guarding installed. Light Curtain alignment is preset at the factory. Light Curtain Set consists of a Transmitter and Receiver Unit *(see Figure 1-7)*.

1. Check for signs of external damage to the light curtain transmitter, receiver, or cables and wiring.

2. Inspect electrical connections between guarded machine's control system and light curtain. Verify they are properly connected.

3. Turn on power to machine.

4. Verify that curtain is in alignment. The individual beam indicators located on the receiver will illuminate when alignment of a beam is not met *(refer to Figure 1-7)*.



SENDER UNIT LIGHTS		
	Floating Blanking (Receiver)	Light indicates that one or more of the beams has been deactivated. This light should not be illuminated. If it is, contact a Sunnen representative for repair.
	Machine Run (Receiver)	Light indicates the protected machine is allowed to operate
	Machine Stop (Receiver)	Light indicates the protected machine is not allowed to operate
	Interlock (Receiver)	Light indicates the protected machine is not allowed to operate until the protected zone is cleared and the start button is pressed and released
	Status Indicator (Transmitter)	Indicates the light curtain is functional

FIGURE 1-7, Light Curtain

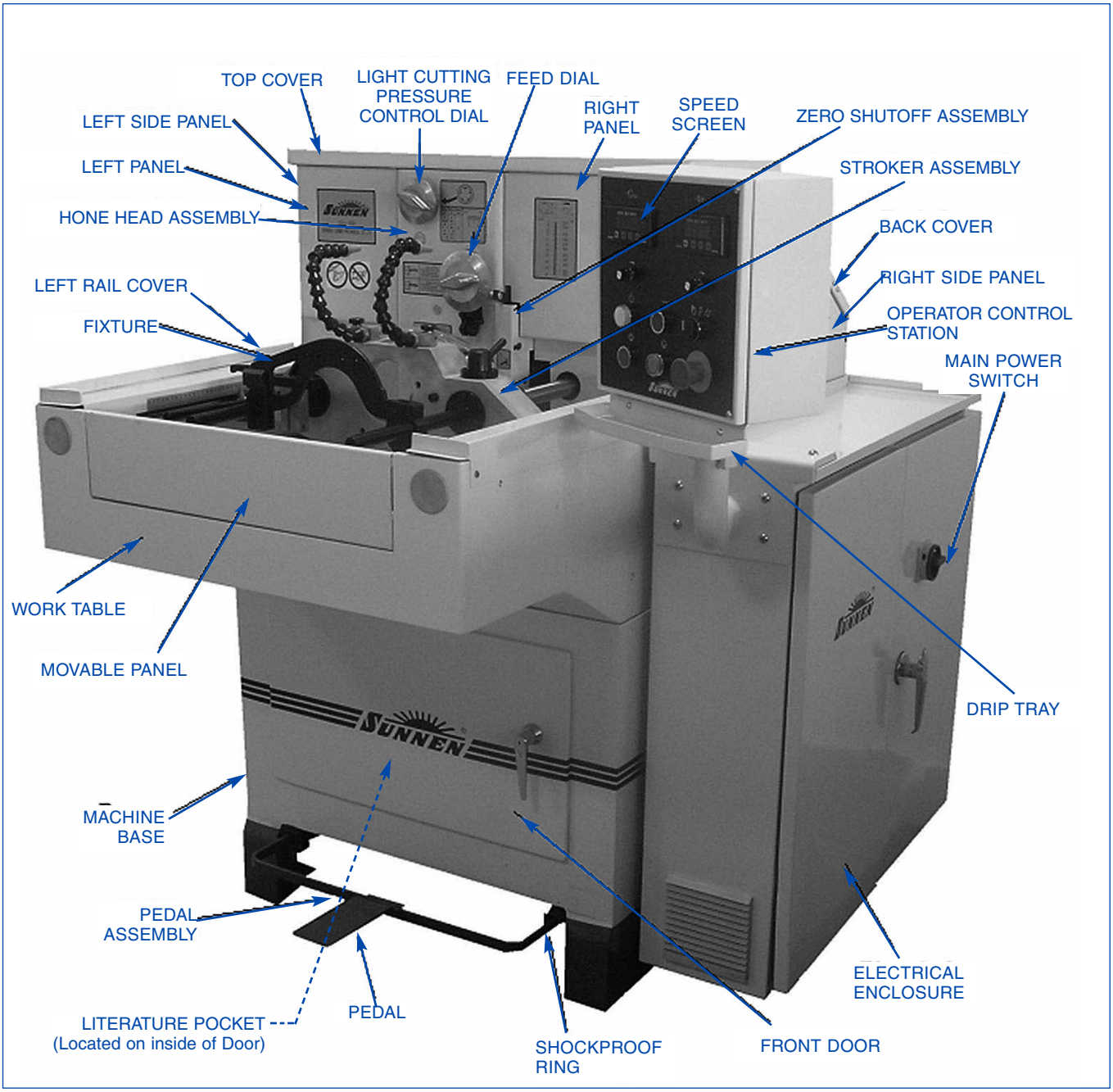


FIGURE 2-1, Major Components

SECTION 2
PREPARING FOR OPERATION

GENERAL

This section should be consulted when preparing the Machine for operation.

MAJOR COMPONENTS

For location of major components on the machine (see Figure 2-1).

1. MACHINE BASE: The precision honing machine is equipped with the base of cast iron to support the hone head assembly and houses components.

2. WORKTABLE: It is the work area. Dual rails are installed on both sides. The stroke support is fixed on moveable linear bearings. In order to protect the stroke support, two limit switches are installed on the bottom of the right rail. Honing fixture and coolant pipe can be attached to the stroke structure (see Figure 2-2).

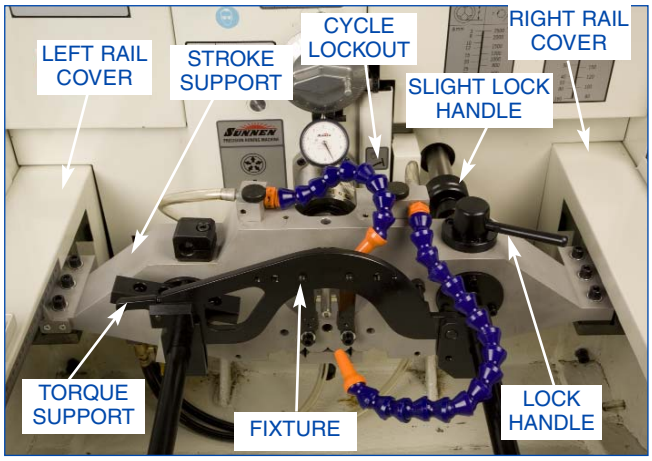


FIGURE 2-2, Worktable

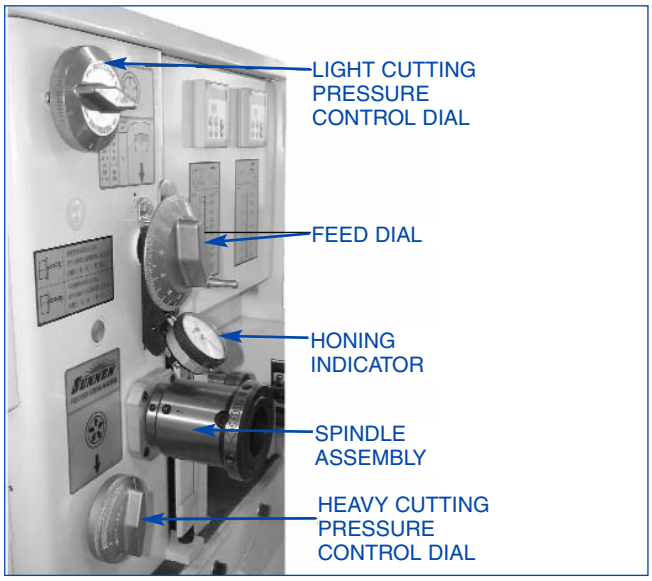


FIGURE 2-3, Hone Head Assembly

3. HONE HEAD ASSEMBLY: It includes the following major parts (see Figure 2-3 & Table 2-1):

Spindle: It is located on the lower right of the assembly. Honing tool is installed in the bore of spindle. Four (4) screws on the two ends of the spindle are used to adjust tool conical and parallel runout.

Feed Dial: It is located on the front center of the assembly, and linked with the feed arms through a screw. It is used to set the honing stone expansion.

Light Cutting Pressure Control Dial: It is located on the top left of the assembly. It is used to adjust the cutting pressure of the honing stone for small diameter bores, soft materials, rough bores or fine finishes.

Heavy Cutting Pressure Control Dial: It is located on the lower left of the assembly. It is used to adjust the cutting pressure of the honing stone where heavy stock removal is required.

The Spindle Drive Motor: It is located on the back left of the assembly, and installed on the base. It supplies power for the honing operation.

4. PEDAL ASSEMBLY: It is located on the front and inside of the machine base and linked with start operation and zero shutoff mechanisms through a pull rod, when the pedal assembly is depressed, it starts the machine and expand the stone (while manual honing), or starts the spindle motor and stroker motor at the same time (while Semi-Automatic).

5. STROKE ASSEMBLY: It is located on the back of the machine. It is composed of stroke motor, stroke drive structure (Rod Screw Support), stroke connection rod, stroke slide rod and other major components. It is connected to stroke support with fine adjustment locking mechanism (see Figure 2-4)

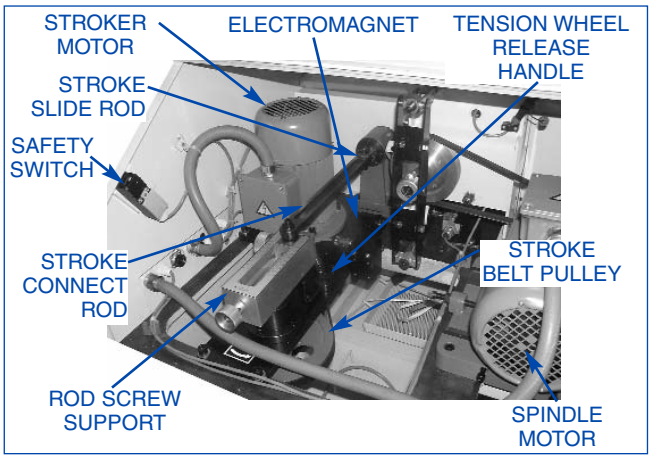


FIGURE 2-4, Stroke Assembly

6. COOLANT ASSEMBLY: The coolant pump is a centrifugal unit. It is located on top of coolant cart. ting the individual coolant nozzle control valves. The return honing oil flows into the filter basket and flows back to coolant cart through outlet oil pipe (see Figure 2-5). Coolant flows through oil pipe, flow control manifold and coolant nozzles (see Figure2-6). The flow control manifold includes two individual coolant nozzle control valves.

7. SAFETY SYMBOLS: For a description of safety symbols used on this machine, refer to Table 2-1.

8. ELECTRICAL COMPONENTS: It consists of Electrical Enclosure, Operator Control Station, Limit Switch, Safety Switch and so on:

Electrical Enclosure: Enclosure is located on the right of the machine. In the electrical enclosure, there are inverters, transformers, contactors, and overload protection control fittings. The power source is 380V, 50Hz, 3PH or 230V, 60Hz, 3ph, depending on machine, to connect the factory power. The inverter connects to the digital displays, and can display and set the spindle speed and stroke speed.

Operator Control Station: Station is located on the front right of the machine and is connected to the electrical enclosure (see Figure 2-7 & see Table 2-2).

Stroke Limit Switch: Switch is located on bottom of the right rail, to control the stroke range of the carriage, and it is used for protecting the machine.

Safety Switch: A Safety Switch is located inside the back cover on the side of the machine (refer to Figure 2-4). When the back cover is open, the machine is inoperative. The back cover must be closed and turn on the power, before the machine can be operated.

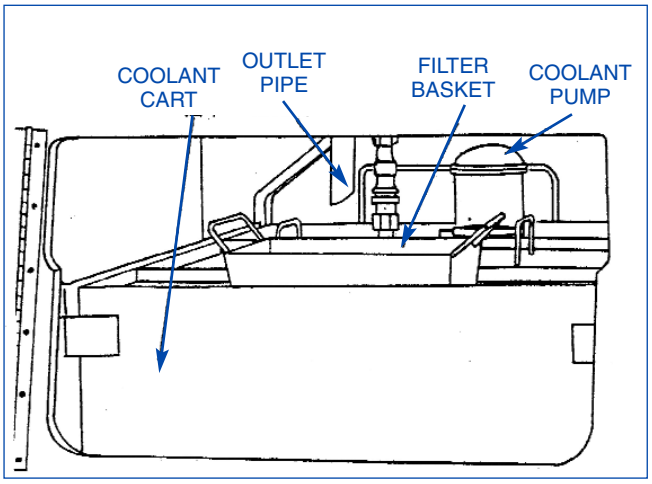


FIGURE 2-5, Coolant Assembly

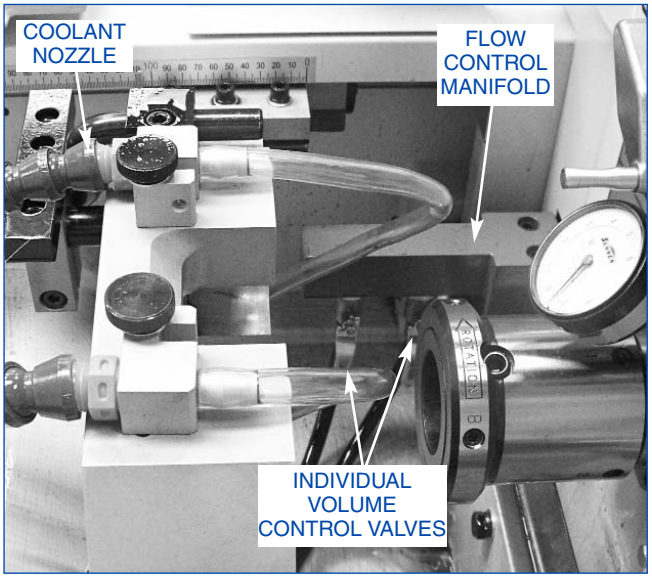


FIGURE 2-6, Coolant Assembly

TABLE 2-1, Safety Symbols

SYMBOL	DESCRIPTION	FUNCTION
	Warning Label	Warns that an electrical hazard exists.
	Warning Label	Indicates the rotation of spindle motor.
	Warning Label	Indicates the rotation of stroker motor.
	Warning Label (Safety Glasses)	Warns that safety glasses should be worn at all times when operating this machine.
	Warning Strip	Warns that a *physical hazard exists*, and that proper precautions should be taken.
	Caution Label Moving Parts	Warns that a finger hazard exists. Do not touch while stroker is operating.
	Warning Label	Warns not to hold workpiece in hand without a torque resisting fixture.
	Foot Pedal	Starts honing cycle and controls stone expansion.

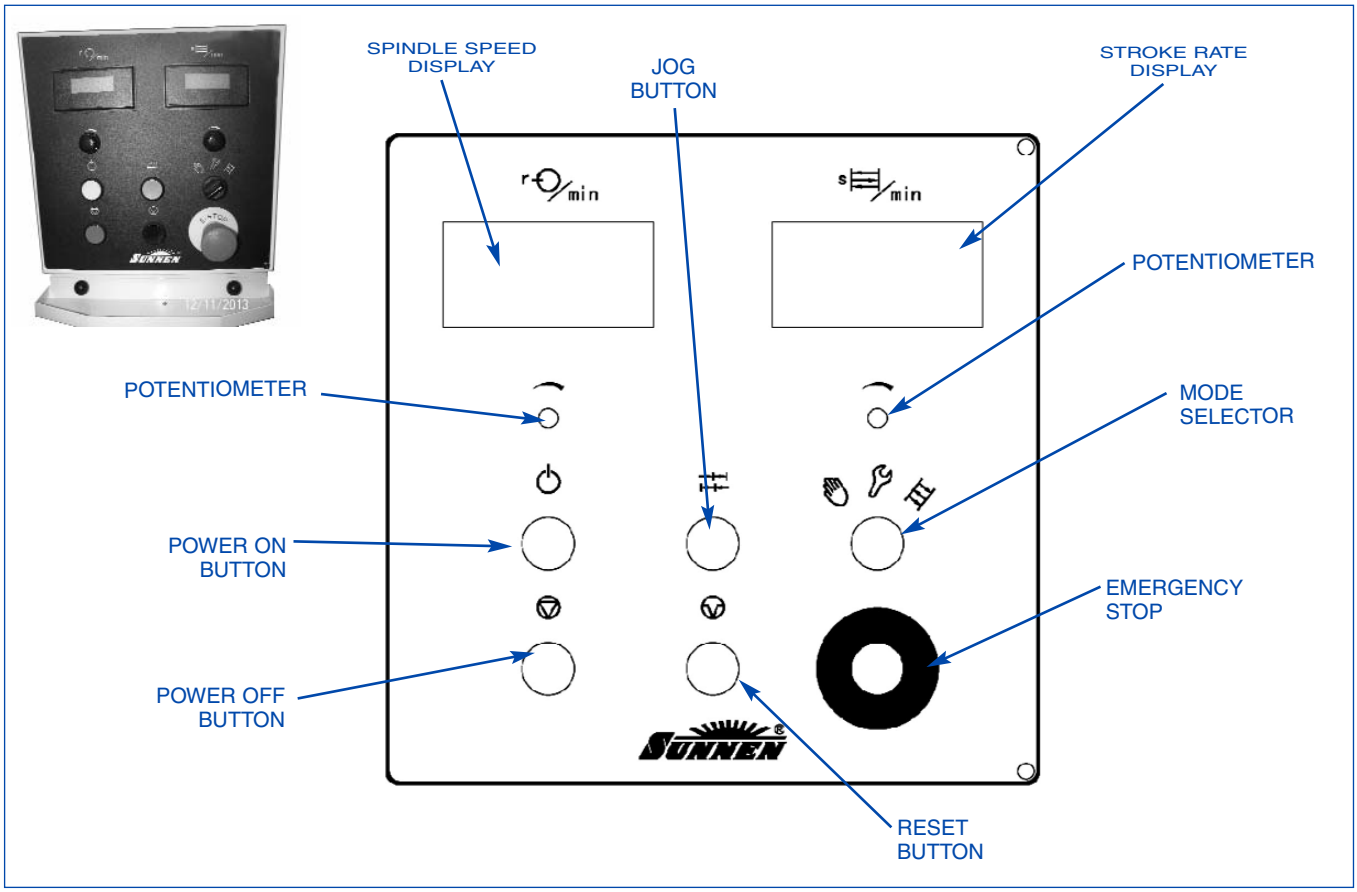


FIGURE 2-7, Operator Control Station

TABLE 2-2, Operator Controls

SYMBOL	DESCRIPTION	FUNCTION
r/min	(SPINDLE SPEED) Display	Display the spindle speed.
s/min	(STROKE RATE) Display	Display the stroke speed (rate).
	(POTENTIOMETER) Black Knobs	The potentiometer on the left is to adjust the spindle speed; The potentiometer on the right is to adjust the stroke speed.
	(POWER ON) White Pushbutton Switch	Turns ON electrical power, and starts Coolant Pump Motor.
	(POWER OFF) Red Pushbutton Switch	Shuts off electrical power and stops Coolant Pump.
	(JOG BUTTON) Black Pushbutton Switch	Jog the moving of stroke.
	(RESET BUTTON) Blue Pushbutton Switch	STOPS honing cycle and resets cycle.
	MODE SELECTOR (MANUAL/NONE/AUTO) 3 Position Selector Switch	MANUAL – Selects manual stroke honing. NONE – Unlatched setting (Machine is at idle state). AUTO – Auto setting is for power honing. Depressing the foot pedal can start power honing immediately.
	(Emergency Stop) Red Locking Pushbutton Switch	Controls electrical power to STOP ALL Machine functions; Before restarting the machine, rotated E-Stop Button clockwise and release the locking mechanism.

9. COVERS: It consists of the left panel, the right panel, the left side panel, the right side panel, the backside panel, the top cover and the back cover.

10. ACCESSORIES:

a) Manual Torque Support Bars (Inch) (9/64", 3/16")

b) Hex Wrench (Inch) (1/4", 5/32", 1/8", 3/32", 5/64")

c) Hex Wrench (Metric) (3mm, 5mm, 6mm, 8mm)

d) MBC-400 Runout Indicator

e) Work Tray, Splash Panels

SETUP - GENERAL

1. Press E-STOP Button to ensure power is OFF and lock is engaged.

2. Turn ON Main Power Disconnect at Main Electrical Control Enclosure (power indicator on operator control panel is lit).

3. Turn E-Stop button clockwise, and release locking mechanism.

4. Set Mode Selector Switch to NONE position, and push RESET pushbutton.

5. Turn OFF Coolant supply, by turning two Individual Control Valves, Coolant Flow Control Manifold,.

6. Rotate Cycle Lockout (Zero-Shutoff) fully clockwise (see Figure 2-8).

7. Select Honing Unit and Stone from Sunnen Bore Sizing and Finishing Supplies Catalog (X-SP-5500).

Depending on your part configuration, select a honing unit type and size most suitable.

Assemble honing unit by using instructions included with your new mandrel and/or adapter.

8. Select Stone from Sunnen Bore Sizing and Finishing Supplies Catalog (X-SP-5500).

Determine amount of stock to be removed and number of operations required to getting workpiece to proper size and surface finish. Many times a three stone operation is the most economical - that is: deburring, fast stock removal, and fine finishing. If deburring is attempted with a stock removal stone, excessive stone wear will result. If stock removal is attempted with a deburring stone or finishing stone, honing time will be excessive.

Use a harder stone to improve stone life. Use a softer stone to promote freer cutting.

Use a coarse stone for fast stock removal and a fine stone for finishing. Always use the coarsest stone that will produce an acceptable surface finish.

Short open bores, blind bores, and tandem bores may require minor alterations of standard stones.

9. Assemble Honing Unit: According to instructions packed with Honing Unit.

10. Turn Feed Dial counterclockwise until you meet resistance, then advance dial clockwise about five (5) turns (see Figure 2-9).

11. Pull Mandrel Wedge straight back as far as possible, using hook on end of T-Wrench (see Figure 2-10).

12. If required, install Spindle Sleeve (LN-570A) on honing unit. If honing unit fits into spindle very loosely, use a Spindle Sleeve (see Figure 2-11).

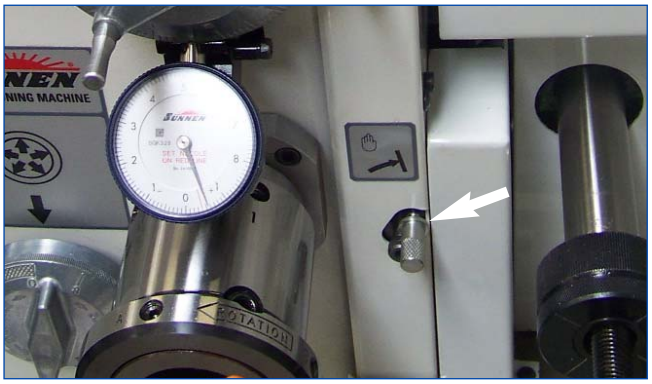


FIGURE 2-8, Cycle Lockout (Zero-Shutoff)

FIGURE 2-9, Feed Dial

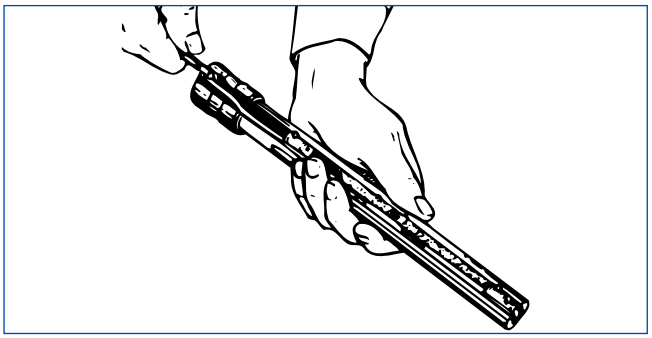


FIGURE 2-10 Mandrel Wedge

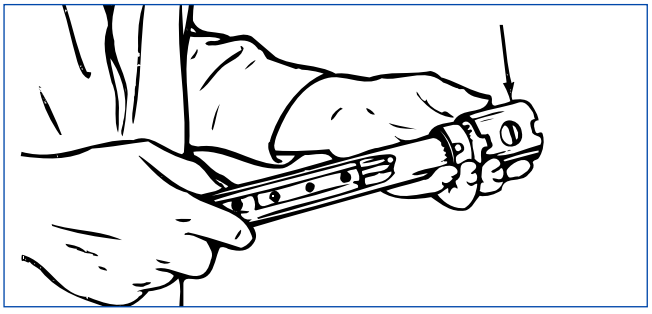


FIGURE 2-11, Spindle Sleeve

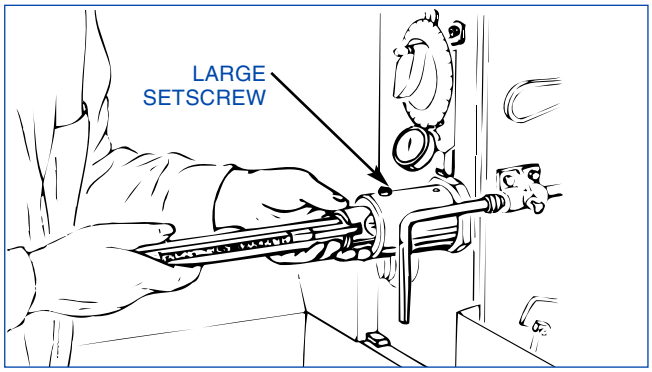


FIGURE 2-12, Install Mandrel

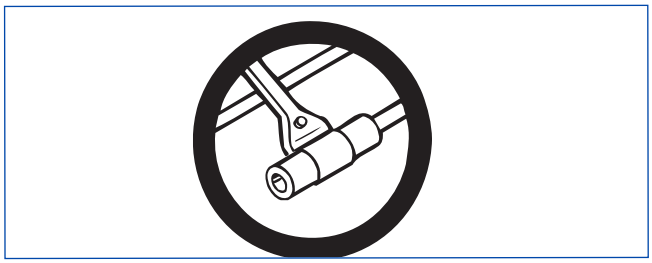


FIGURE 2-13, Workholding Fixture

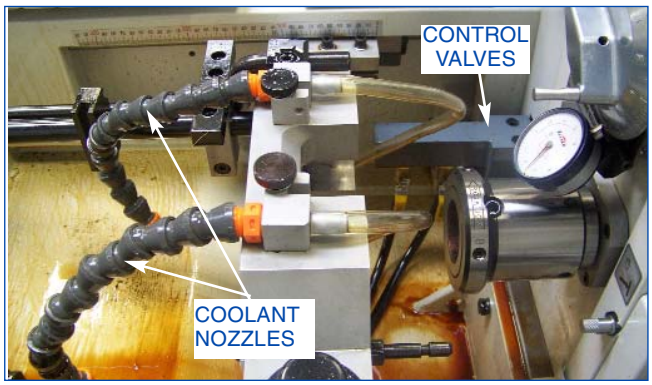


FIGURE 2-14, Coolant

13. Remove Spindle Cover.

14. Rotate Spindle so Large Set Screw points up (Screw is in 12 o'clock position).

15. With setscrew indentation on honing unit at 9 o'clock position, insert Honing Unit into Spindle Nose as far as it will go; rotate unit 1/4 turn clockwise to engage Wedge with Feed Rod; then push Honing Unit all the way in until it bottoms (see Figure 2-12).

16. Test Wedge hookup by pulling Honing Unit straight out; if Wedge comes out repeat steps 9 thru 16. If wedge is hooked up, it will not allow unit to come out of spindle.

17. Push unit back into Spindle Nose until it bottoms.

18. Tighten Large Set Screw with T-Wrench.

NOTE: CR-Series of Honing Units stones and shoes are self truing; no truing sleeve is furnished or required. TRUE IN MANDREL AND STONE.

TRUE IN MANDREL

1. Rotate Cycle Lockout (Zero-Shutoff) fully clockwise (refer to Figure 2-8).

2. Turn Feed Dial counterclockwise until you feel resistance.

3. Place a Truing Sleeve or a suitable undersized workpiece in a torque absorbing workholding fixture (see Figure 2-13).

4. Install Truing Sleeve (in Workholding Fixture) on mandrel.

5. Set Light Cutting Pressure to “2.”

6. With motor off, depress Pedal and turn Feed Dial clockwise until Honing Dial Needle reads "3"

7. Release Pedal.

8. Rotate E-STOP Button counterclockwise to release lock.

WARNING

Power to the machine is ON. Spindle will rotate when Foot Pedal is pressed.

9, Push POWER ON Button.

10. Slowly open two Individual Control Valves. Generously apply coolant to honing stone, guide shoes, and bore of Truing Sleeve (see Figure 2-14). Close Total Volume Control Valve.

11. Set spindle speed to 250 rpm.

12. Set Mode Selector switch to manual stroke.

13. Center Truing Sleeve over stone and shoes.

CAUTION

Make sure that the Truing Sleeve is held in a workholding fixture that transmits torque to the Manual Torque Support (see Figure 2-13).

14. Grasp Workholding Fixture and Truing Sleeve firmly and depress Pedal slowly.

15. As mandrel begins its rotation, stroke Truing Sleeve forward and back. Use short strokes at first, then gradually lengthen stroke until stroke length is about as long as stone or Truing Sleeve, whichever is longer.
If Truing Sleeve is too hard to hold or Honing Dial Needle moves too rapidly, reduce cutting pressure. If Honing Dial Needle does not move or moves too slowly, increase cutting pressure.

16. The coolant on Truing Sleeve and stone create a lapping paste as you are honing; as paste dries out, add a small amount of Coolant.
Always hone workpiece most where you feel most pull or resistance.

17. When Honing Dial Needle reaches "0", release Pedal.

18. Advance Feed Dial four (4) numbers; Depress Pedal and continue honing until Honing Dial Needle reaches "0"; then release Pedal.

CAUTION

Always release Pedal before removing Truing Sleeve from mandrel.

19. Reverse Truing Sleeve frequently. After reversing Truing Sleeve several times stop and examine stone and shoes.

NOTE: High spots on stones will be loaded (see Figure 2-15. Use the LBN-700 Abrasive Stick to remove high spots on stone. High spots on shoe will be bright and shiny. A few light strokes with a file will remove these high spots (use an abrasive stick like the LBN-700 to true hardened steel guide shoes).

20. Repeat above operation, until at least a line contact is achieved on each shoe and on stone.

NOTE: The objective of truing the mandrel and stone is to make the shoes and stones parallel. However, when honing to very close tolerances or when honing holes with keyways, the honing unit should also be trued to the finish bore diameter as closely as possible. When truing Keyway (Y-type) mandrels, refer to instruction sheet packed with mandrel. Keyway mandrels should be fully radiused to within .005" (0.13 mm) of workpiece finish bore size.

21. When mandrel is trued in, push STOP Button.

22. Replace Spindle Cover.

MANDREL RUNOUT ADJUSTMENT

Eliminate conical and parallel runout as follows:

NOTE: Mandrel and Stones must be trued before adjusting conical and parallel runout.

1. Select proper Sunnen Alignment Bushing. (Resize I.D. of bushing if necessary.)

2. Rotate Cycle Lockout (Zero-Shutoff) fully clockwise (refer to Figure 2-8).

3. Turn Feed Dial counterclockwise until you feel resistance.

4. Install Alignment Bushing on the mandrel (see Figure 2-16).

5. With Power OFF; Depress Pedal and turn Feed Dial clockwise until Honing Dial Needle reads “5”.

6. Release the Pedal.

7. Install Runout Indicator on Stroking Arm (see Figure 2-17). Slide Indicator on Pivot Pin until Spring Clip engages slot in pin.

8. Release Stroker Carriage Lock and center Gage Points over Alignment Bushing.

9 Align Runout Indicator with Alignment Bushing.

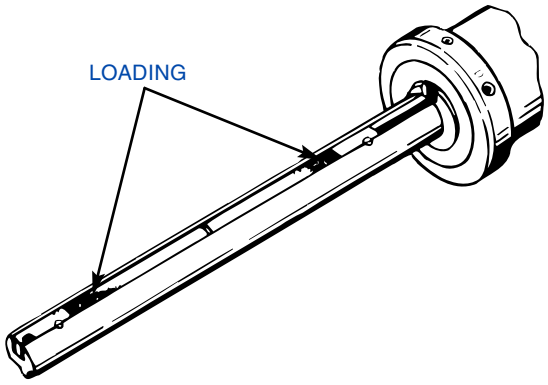


FIGURE 2-15, Stone Loading

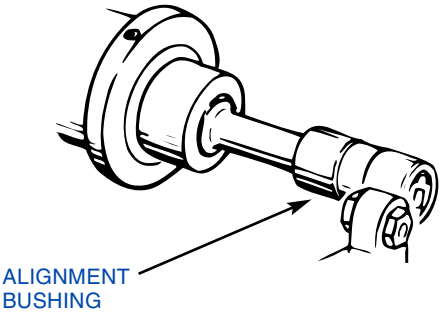


FIGURE 2-16, Alignment Bushing

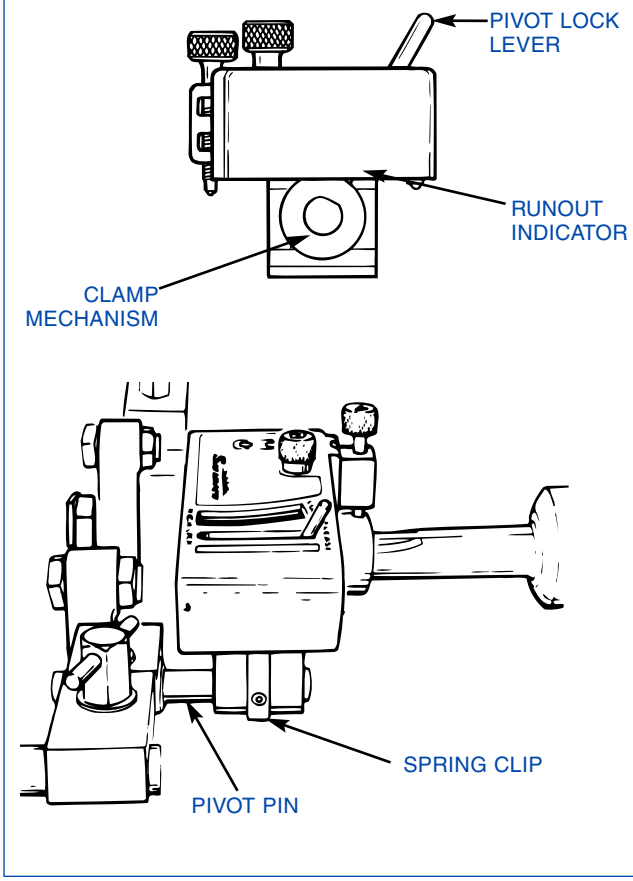


FIGURE 2-17, Runout Indicator

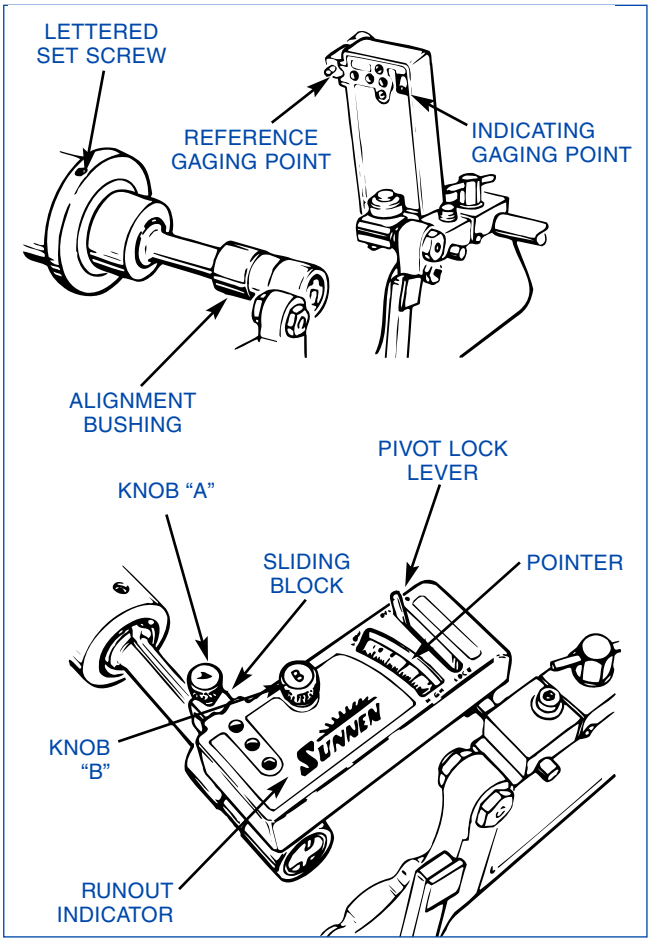


FIGURE 2-18, Runout Indicator Adjustment

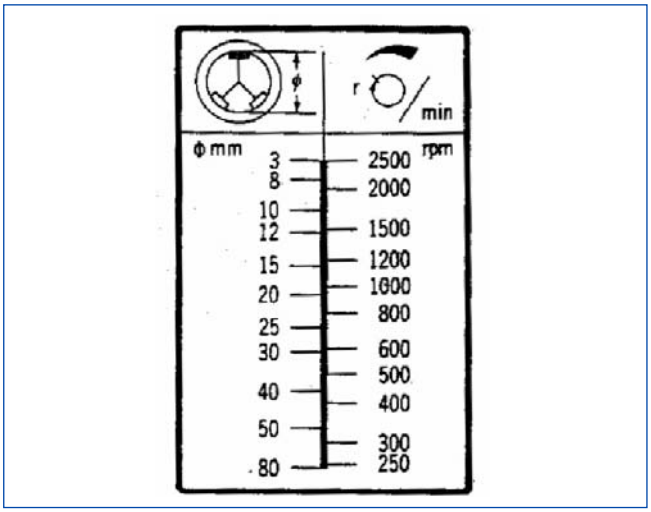


FIGURE 2-19, Spindle Speed

10 Adjust spacing of gaging points on Runout Indicator so points are as far apart as Alignment Bushing permits (see Figure 2-18).

11. Release Pivot Lock Lever.

12. Turn Knob A in either direction to set Runout Indicator Pointer to "0" (approximate).

13. Rotate Spindle by hand to locate lowest reading on gage; readjust Knob A as required so low point can be located.

TABLE 2-3, Spindle Speed Selection

WORK DIAMETER		SPINDLE
inches	millimeters	SPEED
UNDER .308	UNDER 8	2500
.308 - .432	8-11	2000
.432 - .495	11-13	1600
.495 - .619	13-16	1270
.619 - .744	16-19	1000
.744 - 1.000	19-25	800
1.000 - 1.250	25-32	640
1.250 - 1.625	32-41	500
1.625 - 2.000	41-51	400
2.000 - 2.500	51-64	320
2.500 - 3.250	64-83	250
OVER 3.250	OVER 83	200

CAUTION: Power MUST be OFF when Guard is open.

14. Loosen Lettered Set Screw(s) in Spindle Nose on side with lowest reading; and tighten Lettered Set Screws on opposite side

15. Repeat as required, until conical runout has been reduced to 1 division.

16. Move Pivot Lock Lever to lock position.

17. Turn Knob A counterclockwise one full turn.

18. Turn Knob B in either direction to set Runout Indicator Pointer to "0" (approximate).

19.Rotate Spindle by hand to locate highest reading on gage; readjust Knob B as required so high point can be located.

20. Loosen Numbered Set Screw(s) in Spindle Nose on side with highest reading, and tighten Numbered Set Screws on opposite side.

21. Repeat as required, until parallel runout has been reduced to 1 division.

22. Release Pivot Lock Lever.

23. Pull Spring Clip out slightly and slide Runout Indicator off Pivot Pin.

24. Turn the E-Stop button clockwise, and release the locking mechanism.

26. Press "Reset" pushbutton and remove Alignment Bushing.

26. Turn cycle lock out fully clockwise.

27. Press E-STOP Button.

28. Reinstall Spindle Cover.

SPINDLE SPEED

1. Look up spindle speed according to bore size (see Figure 2-19 & Table 2-3).

2. Turn Potentiometer on the left (for spindle), until it displays desired spindle speed (see Figure 2-20).

TABLE 2-4, Cutting Pressure Setting

BORE SIZE		PRESSURE CONTROL
inches	millimeters	INITIAL SETTING
1,5 - 2,5	.060 - .100	0
2,5 - 5,0	.100- .185	1/8
5,0 - 6,0	.185 - .245	1/4
6,0 - 9,0	.245 - .370	1/2
9,0 - 12,0	.370 - .495	3/4
12,0 - 25,0	.495 - 1.000	1
25,0 - 92,0	1.000 - 3.625	2
92,0 - 165,0	3.625 - 6.500	2-1/2

NOTE: The customer can only adjust spindle speed and stroke speed. The other parameters are locked by Sunnen Company according to design. So the customer cannot change them by himself, otherwise the customer will assume all duties. If the customer have special demands and need to change the parameters, please contact to Sunnen company, we will supply all support and help, don't change them by yourself.

3. Adjust light cutting pressure control according to bore size and adjust heavy cutting pressure control to "0" (see Table 2-4 or your Sunnen SMOPS Guide).

STROKE LENGTH

1. Measure length of bore to be honed and length of stone.

If part is shorter than stone
stroke length = 0.85 x stroke length.

If part is longer than
stroke length + 0.85 x part length

The longer of two is maximum stroke length. The minimum stroke length must be larger than difference between two.

For workpiece with blind holes maximum stroke length should be bore length, including relief, minus 2/3 stone length.

For workpiece with tandem holes using a solid line of stones, stroke length should equal total stone length minus tandem distance.

For workpiece with tandem holes using separated tandem stone, the maximum stroke length should equal tandem land length or individual stone length; whichever is longer.

2. Open back cover of Machine.

NOTE: There is a safety switch between back cover and right side panel, and power will be shut off automatically when cover is opened to ensure operator safety.

3. Loosen Lock Screw on Stroke Drive (see Figure 2-21).

4. Adjust length of stroke, by rotating Adjusting Knob, according to Stroke Rule.

FIGURE 2-20, Potentiometer

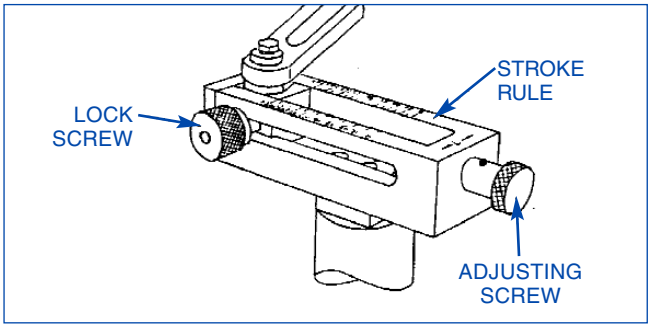


FIGURE 2-21, Stroke Length

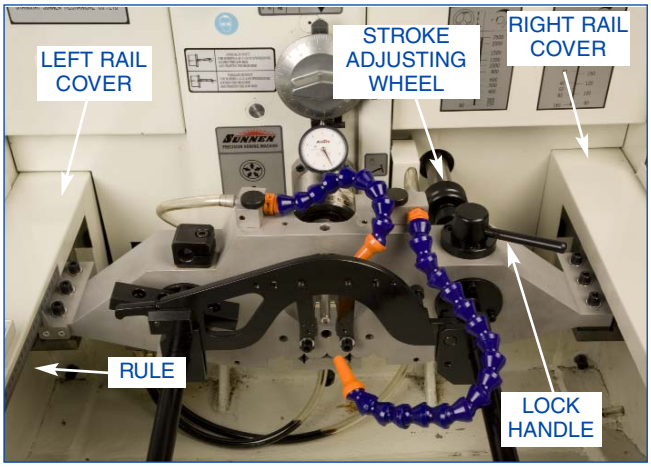


FIGURE 2-22, Overstroke

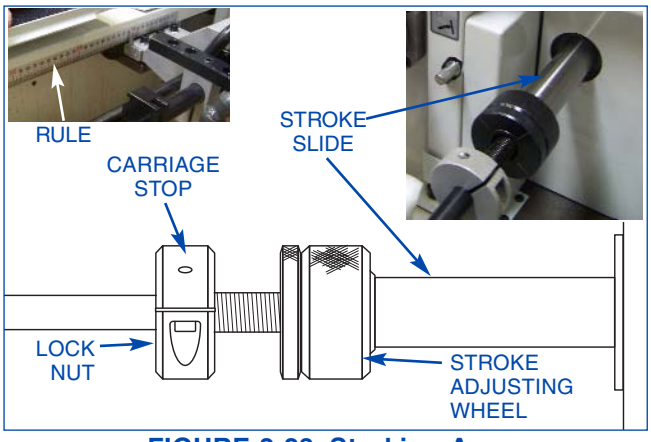


FIGURE 2-23, Stroking Arm

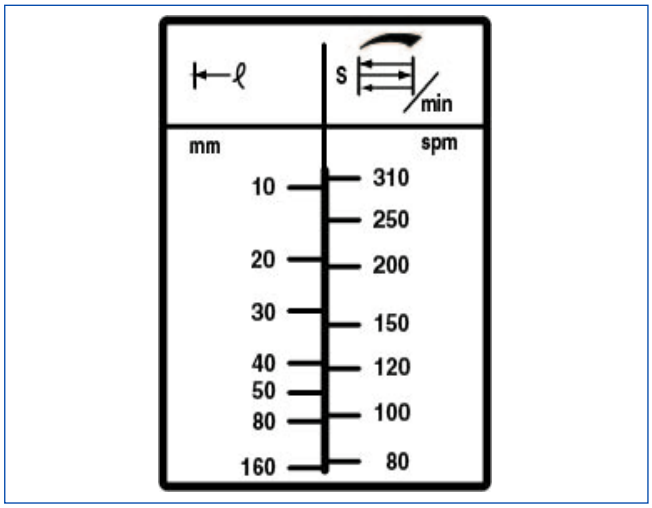


FIGURE 2-24, Stroke Speed

FIGURE 2-26, Potentiometer

5. Then tighten Lock Screw.

6. Close Back Cover. Safety switch has been pressed.

TORQUE SUPPORT

1. Reinstall workpiece on mandrel.

2. Lower stroker gate and stroker arm.

3. Loosen capscrew in torque support and roller assembly. Center assembly under workholding fixture, and tighten capscrew.

4. Check clearance between torque support and roller assembly, and adjust as required.

5. Tighten capscrew in torque support and roller assembly.

STROKE POSITION

CAUTION

In order to avoid injury and damage to machine, first place workpiece in holding fixture, then install it on the mandrel.

1. Loosen clamping blocks on gate and lock screw, and slide gate open enough so gate will clear workpiece. .

2. Install workpiece in holding fixture on mandrel.

3. Turn cycle lockout fully counterclockwise.

4. Press E-Stop button, and make sure power is off.

5. Depress pedal and turn feed dial clockwise until honing dial reads “2”, and then release pedal.

6. Loosen stroker lock handle, and move stroking arm so front stroking fingers are lined up with workpiece.

7. Adjust rear stroking fingers. Then tighten stroker lock handle.

8. Slide gate close to workpiece, allowing sufficient clearance between workpiece and gate fingers to prevent binding, approximately 0.8mm.

9. Tighten clamping blocks and lock screw.

10. Loosen stroking fingers, and move fingers in toward mandrel so they will contact workpiece face adjacent to bore. Then tighten stroking fingers.

11. Both front and rear fingers should clear part as it is manually rotated.

12. Turn E-Stop button clockwise to release the locking mechanism.

13. Press Reset button and remove workpiece from mandrel.

14. Rotate Cycle Lockout (Zero-Shutoff) fully clockwise (refer to Figure 2-8).

15. Close coolant control valves.

16. Press POWER ON pushbutton.

17. Before adjusting stroke position, unlock lock handle and push carriage toward rear. Then relock handle. This is to ensure carriage is back touching stroke stop.

18. Press Stroke Jog pushbutton, stroke carriage will move forward and back slowly.
Check to make sure stroke clears all obstacles, and that both overstrokes are equal.
The position can be aligned with rule on worktable left rail cover (see Figure 2-22).
If stroke's position needs to be adjusted: Loosen lock Nut, rotate adjusting wheel, until the value on left rule is at correct position (see Figure 2-243). Then relock Nut.

STROKE SPEED

1. Look up stroke speed according to the table of stroke length (see Figure 2-24). For example 150spm.

2. Turn the Potentiometer on the right (for stroke), until it displays “150” (see Figure 2-25).

3. “Power ON” button to start honing parts.

NOTE: The customer can only adjust spindle speed and stroke speed. The other parameters are locked by Sunnen Company according to design. So the customer cannot change them by himself, otherwise the customer will assume all duties. If the customer have special demands and need to change the parameters, please contact to Sunnen company, we will supply all support and help, don't change them by yourself.

4. Setup is complete, proceed to Section 3, Operation.

SECTION 3
OPERATION

GENERAL

This section describes a step-by-step operating procedure for the SSH-1680. Prior to starting Machine, Operator shall ensure:

1. All prerequisites described in sections 1 and 2 are complete.
2. All personnel are clear of machine.

SAFETY PRECAUTIONS

The following precautions should be followed to ensure maximum safety of personnel while working on or around Precision Honing Machine.

1. Ensure all guards are in place before operating.
2. Ensure area is clear of other personnel before operating machine.
3. Keep machine clear of tools or other foreign objects.
4. Wear proper safety items such as, safety glasses, non-slip safety shoes and other personal safety equipment as necessary or required.
5. Do not wear cotton or heavy gloves while operating this equipment! If gloves must be worn, wear only the tear-away type.
6. Do not wear loose clothing or jewelry while working on or around machine.
7. Keep area around machine free of paper, oil, water and all other debris at all times.
8. When lifting part or tooling use proper lifting procedures.
9. Turn OFF electrical power at Disconnect Switch, on Electrical Control Enclosure when preforming service not requiring power.
10. Turn OFF electrical power at Main Power Source when performing maintenance on, or cleaning of Electrical Control Enclosure.
11. Clear area of excessive lubricant or lubricant spills.

Precision Honing Machine Operation

12. Do not adjust stroke length while honing.
13. Stay clear of all moving parts.
14. Remove keys and wrenches from machine before honing.
15. Do not hand hold parts while honing.

OPERATING MODES

The SSH-1680 Precision Honing Machine has the following six modes of operation. The last four modes can employ the Stone Saver.

1. Manual Stroke Honing - is used when honing only a few parts, or special parts. (Parts too long, too heavy or that don't fit in the fixture).
2. Power Stroke Honing - is used for a mass production of the same workpiece, or the large stock removal workpieces although the quantities are not many.
3. E-Stop: When machine is in automatic mode, if you press down E-Stop, machine will stop immediately. To resume work, release E-Stop, press Reset button and power ON button.
4. Machine rear cover:
Power ON State: When machine is in power on state, and press E-Stop Button, wait 2 seconds, then open rear cover.
If rear cover is opened with power ON; power to machine will shut OFF..
5. WARNING: Machine will start when pedal is depressed..

Guidelines

It is impossible to set down exact rules for when you should use each operating mode, but following Guidelines should be of some help.

Manual Stroke Honing is generally used when . . . part's bore is larger then 95 mm (3.750 in.), part is too long or too heavy to economically fixture for power stroking; honing only a few parts.

Power Stroke Honing is preferred when . . . there are many identical parts to be produced; stock removal requirement is large, even on only a few parts.

Since no stroking effort is required of operator in Power Stroke Honing, production rates tend to be much higher.

MANUAL STROKED HONING

1. Press E-STOP Button.
2. Turn Mode Selector Switch to MANUAL.
3. Rotate Cycle Lockout (Zero-Shutoff) fully clockwise (see Figure 3-1).
4. Back off Feed Dial, by turning counterclockwise, to allow part to slide onto Mandrel.

NOTE: On smaller Mandrels Stone may not retract, it may need to be pushed back into Mandrel with your fingers.

WARNING

To prevent personal injury and machine damage, DO NOT hone without installing part in workholding fixture.

5. Gage hole size, using Sunnen Precision Hole Gage, to determine amount of stock to be removed.

6. Install part in Workholding Fixture.

7. Slide part on Mandrel, so part is centered over stone.

8. Depress Pedal.

9. Turn Feed Dial clockwise until Honing Dial readings is equal to amount of stock to be removed, per step 5. For various honing units types refer to Table 3-1, or data plate located above Feed Dial on your machine, for various mandrel types.

10. Turn part several revolutions on Mandrel to seat part on stone.

11. Release Pedal.

CAUTION

Machine MUST be set at proper Spindle Speed and Pressure Control Setting.

12. Release E-STOP Button, by rotating counterclockwise.

13. Press POWER ON Button (White Light ON), and coolant pump starts.

14. Adjust position and direction of coolant nozzle and coolant flow as required.

CAUTION

If bore is rough or out-of- round, DO NOT fully depress Pedal until bore has smoothed up as evidenced by diminishing vibrations.

15. Slowly depress Pedal while stroking part.

Overstroke each end of Stone by 1/3 to 1/2 bore length or stone length, whichever is shorter (see Figure 3-2). Frequently stop machine and reverse part on Mandrel.

NOTE: If Honing Dial Needle moves too slowly, increase Cutting Pressure. If Needle moves too rapidly, decrease Cutting Pressure.

16. When Honing Dial reads “0”, release Pedal.

DO NOT hone beyond “0” on Honing Dial. Honing beyond “0” results in . . . loss of reference point and ability to repeat size on succeeding parts, possible stone glazing and unpredictable finish, unnecessarily prolonged honing operation, loss of accuracy because of stone becoming loose in bore.

TABLE 3-1, Stone Expansion

STONE EXPANSION PER HONING DIAL AND FEED DIAL NO.		HONING UNIT TYPE
.002 in	0,050 mm	AK, AN-600, JK, JAK, K, KR, R28, Y, YY
.001 in	0,025 mm	AL, BAL, BL, BLR, L, LR, P20, P28
.0003 in	0,008 mm	D2, D8

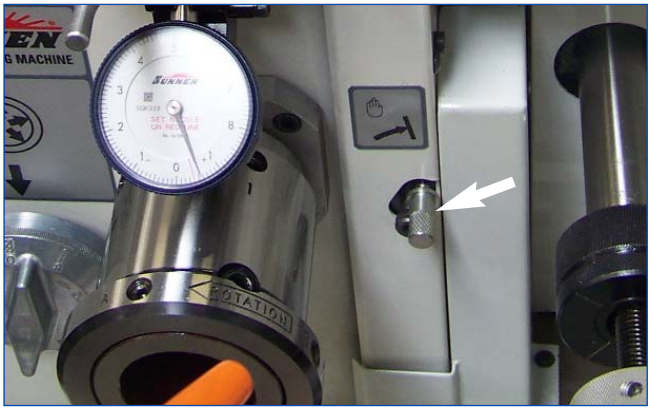


FIGURE 3-1, Cycle Lockout

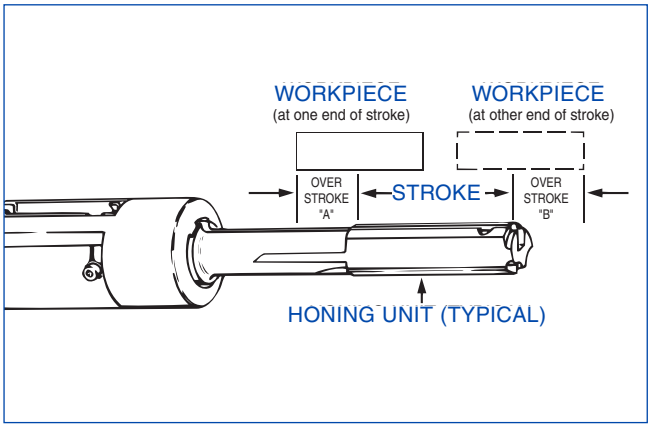


FIGURE 3-2, Overstroke

TABLE 3-1, Spindle Speed

SPINDLE-SPEED IN RPM					
ø in mm	RPM	ø in mm	RPM	ø in mm	RPM
under 40	430	155	113	360	48
45	388	160	110	380	46
50	350	165	106	400	44
55	318	170	103	425	41
60	292	175	100	450	39
65	270	180	97	475	37
70	250	185	95	500	35
75	233	190	92	525	33
80	219	195	90	550	31
85	206	200	88	575	30
90	195	210	84	600	29
100	175	220	80	625	28
105	167	230	76	650	27
110	160	240	73	675	26
115	152	250	70	700	25
120	146	260	67	725	24
125	140	270	65	750	23
130	135	280	63	800	22
135	130	290	60	850	21
140	125	300	58	900	20
145	121	320	55	950	18,5
150	117	340	51	1000	17,5

17. Remove workpiece from the mandrel and gage bore size, using Sunnen Precision Hole Gage.

TABLE 3-2, Feed Rate

DIAMETER mm	DIAMETER in.	SPINDLE SPEED RPM	FEED SETTING % ROUGH[1]	FEED SETTING % FINISH[2]
50	2	350	10%	30%
75	3	230	10%	40%
100	4	175	20%	50%
125	5	140	20%	60%
200	8	88	20%	70%
305	12	58	20%	75%
380	15	46	20%	75%

FOR FASTER STOCK REMOVAL INCREASE FEED.

IF STONES WEAR RAPIDLY:
- Reduce Feed Rate
- Use Harder Stones

[1] Always use this setting during the first few (roughing) strokes.

[2] For finishing use Feed Setting of 15% to 20%.

18. Repeat as necessary until desired hole size is reached.

19. Repeat honing operation for remaining parts. When honing several parts, with each honing operation bore diameter will be undersize by amount of stone wear. By noting Honing Dial reading as you start honing each part, you can tell whether stock to be removed is uniform from part to part.

When parts have a uniform amount of stock to be removed, you can accurately estimate how much stone feed-up is needed before starting to hone. Adjust Feed Dial accordingly and hone until Honing Dial reads “0”. If you accurately estimated rate of stone wear, when dial reads “0” part will be honed to size. This allows part to be honed in one operation, without having to gage and hone each part several times until it is to size.

When parts vary widely in amount of stock to be removed, you can NOT estimate how much stone feed-up is needed. Generally it is better to hone part until Honing Dial reads “0”, gage hole, advance Feed Dial accordingly to compensate for stone wear, and then continue honing until hole size is reached.

20. The cutting pressure should be just enough to produce good cutting action. Heavier pressure may cause excessive stone wear; lighter pressure may result in stone glazing instead of cutting. Increase or decrease cutting pressure no more than 1/2 division at a time until most efficient pressure is established. Changing cutting pressure will cause a slight change in reading of Honing Dial. Increasing pressure results in a smaller reading and decreasing it could cause bore to go oversize. For additional troubleshooting information, see Section 5, Troubleshooting.

POWER STROKED HONING

1. Press E-STOP Button.

2. Turn Mode Selector Switch to AUTO.

3. Turn Cycle Lockout fully counterclockwise.

4. Back off Feed Dial, by turning counterclockwise, to allow part slide onto Mandrel.

NOTE: On smaller Mandrels Stone may not retract, it may need to be pushed back into Mandrel with your fingers.

WARNING

To prevent personal injury and machine damage, DO NOT hone without installing part in workholding fixture.

5. Gage hole size, using Sunnen Precision Hole Gage, to determine amount of stock to be removed.

6. Install part in Workholding Fixture.

7. Open Stroking Arm Gate.

8. Slide part on Mandrel, so it is centered over stone.

9. Depress Pedal.

10. Turn part several revolutions on Mandrel, to seat part on stone.

11. Release Pedal.

12. Turn Feed Dial clockwise until Honing Dial readings is equal to amount of stock to be removed, per step 5. For various honing unit types Mandrel types refer to Table 3-1, or data plate located above Feed Dial on your machine.

CAUTION

Machine MUST be set at proper Spindle Speed, Pressure Control Setting, Stroke Length, and Stroke Speed.

13. Close Stroking Arm Gate.

14. Release E-STOP Button, by rotating clockwise.

15. Press POWER ON Button; coolant pump starts.

16. Adjust Coolant Nozzles as required.

17. Press RESET Button one time.

18. Slowly depress pedal to floor and then release. The honing operation will automatically continue until honing cycle is completed.

19. The honing cycle automatically STOPS when Honing Dial Needle reaches “0”.

NOTE: If Honing Dial Needle moves too slowly, increase Cutting Pressure. If Needle moves too rapidly, decrease Cutting Pressure.

WARNING

To avoid personal injury, allow spindle and stroking arm to come to a complete stop before removing part.

20. Open Gate and remove part.

21. Gage bore size, using Sunnen Precision Hole Gage.

22. Place workpiece on mandrel and advance Feed Dial for amount of stock to be removed.

23. Depress pedal and continue to hone to "0' and gage.

24. Repeat as necessary until desired hole size is reached.

25. Repeat honing operation for remaining parts. When honing several parts, with each honing operation bore diameter will be undersize by amount of stone wear. But by noting Honing Dial reading as you start honing each part, you can tell whether stock to be removed is uniform from part to part.

When parts have a uniform amount of stock to be removed, you can accurately estimate how much stone feed-up is needed before starting to hone.

Reset Feed Dial accordingly and hone until Honing Dial reads “0”. If you accurately estimated rate of stone wear, when dial reads “0” part will be honed to size. This allows part to be honed in one operation, without having to gage and hone each part several times until it is to size.

When parts vary widely in amount of stock to be removed, you can NOT estimate how much stone feed-up is needed. Generally it is better to hone part until Honing Dial reads “0”, gage hole, advance Feed Dial accordingly to compensate for stone wear, and then continue honing until hole size is reached.

26. The cutting pressure should be just enough to produce good cutting action. Heavier pressure may cause excessive stone wear; lighter pressure may result in stone glazing instead of cutting. Increase or decrease cutting pressure no more than 1/2 division at a time until most efficient pressure is established. Changing cutting pressure will cause a slight change in reading of Honing Dial. Increasing pressure results in a smaller reading and decreasing it could cause bore to go oversize. For additional troubleshooting information, see Section 5, Troubleshooting.

TABLE 4-1, Lubrication Chart

ITEM	DESCRIPTION	LUBRICANT	PROCEDURE	INTERVALS
1	Feed Screw (3)	SAE #20 Oil	Brush On	Monthly
2	Feed Rod (2)	SAE #20 Oil	Brush On	Monthly
3	Pedal Linkage (3)	SAE #20 Oil	Brush On	Monthly
4	Manual Trip Lever Linkage (1)	SAE #20 Oil	Brush On	Monthly
5	Pull Rod Linkage (1)	SAE #20 Oil	Brush On	Monthly
6	Piston (1)	SAE #20 Oil	Fill	As Needed
7	Linkage (1)	Grease #3	1 Pump	3-6 Months

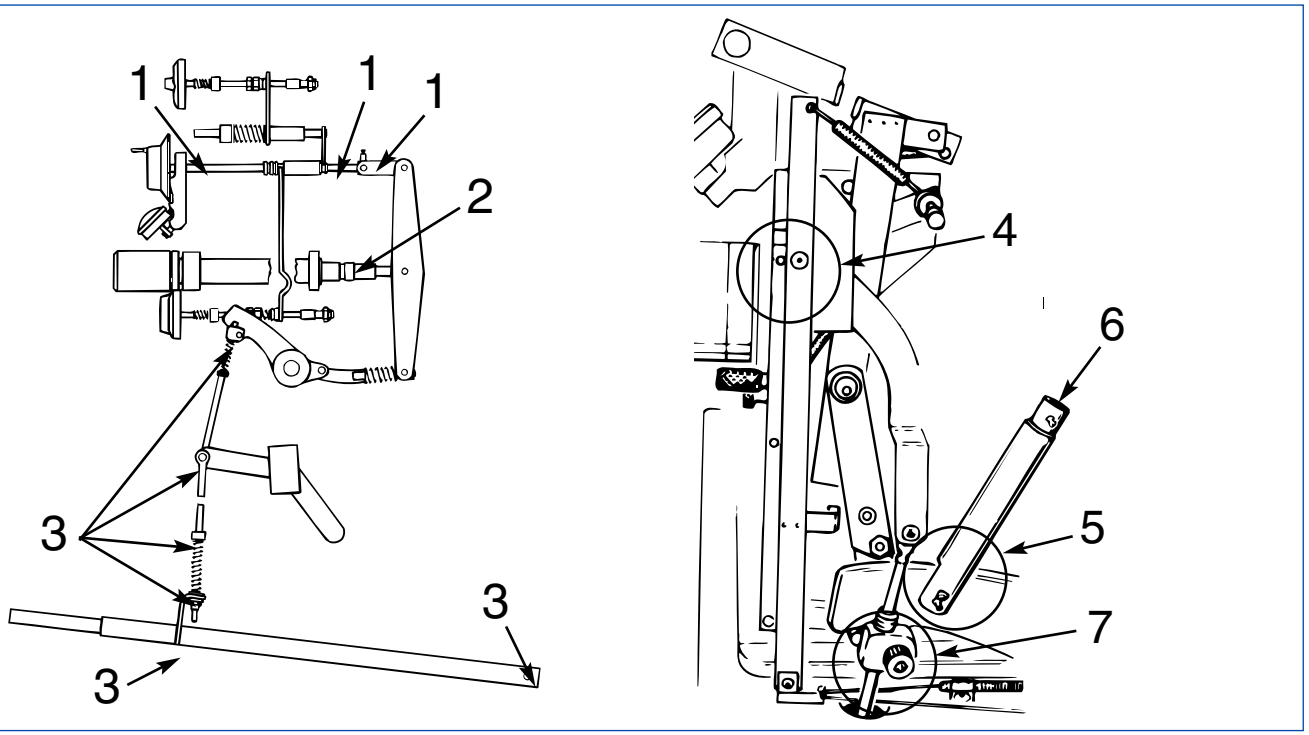


FIGURE 4-1, Lubrication Points

SECTION 4
ROUTINE MAINTENANCE

GENERAL
The following procedures and suggested maintenance periods are given as guides only and are not to be construed as absolute or invariable. Local conditions must always be considered. Each machine must be maintained individually according to its particular requirements.

CLEANING
Monthly, wipe the exterior of the Machine with a clean, dry cloth. Then clean the exterior of Machine with warm water and a mild detergent or mild industrial solvent; rinse thoroughly with clean, hot water and wipe dry.

LUBRICATION
Hand lubricate the various machine components called out in Figure 4-1, according to the suggested intervals called out in Table 4-1.

NOTE: The intervals between lubrication will vary with the amount of use your Machine receives. Lubricate all components at least once every six months.

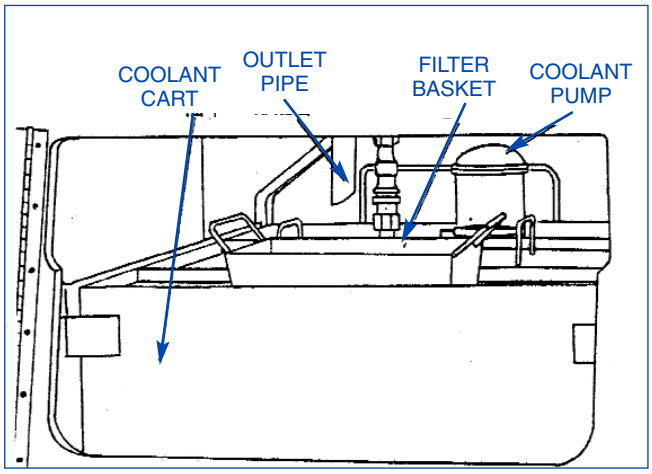


FIGURE 4-2, Coolant Cart

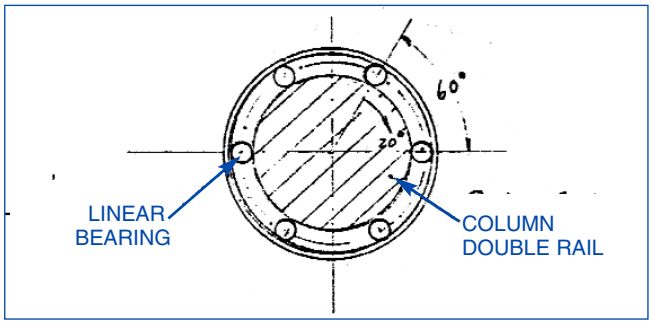


FIGURE 4-3, Column Rail

DOUBLE RAIL & STROKE ASSEMBLY
Four linear bearings on the two sides of the double rail stroke carriage and one on the stroke leading rod are JBD30UU. It is recommended to clean it about every three years according to local use conditions, and re-filled with Grease.

Pin bearings in stroke connecting rods of stroke assembly should be cleaned about every three years according to local use conditions, and re-filled with Grease.

Ball bearings in bearing base of stroke assembly can extend its time to clean and replace Grease, because these bearings are sealed in the bearing base.

CLEANING COOLANT CART
The quality of the bore honing is related to the cleanliness of the coolant. To clean Coolant Cart proceed as follows:
Replace Coolant using ONLY Sunnen Industrial Honing Oil or Sunnen Water Based Coolant. Coolant should be neither diluted or “cut” with other coolant.
Based on machine use, it is recommended that every quarter you pull the coolant cart out from the back of machine, and drain the coolant from the coolant cart (see Figure 4-2).
Clean out coolant cart, and re-fill with clean coolant to desired level. Maintenance in this way can not only reduce the processing cost, but can also ensure the product quality.

ROUTINE ADJUSTMENT
Routine adjustment must be taken into consideration in following seven aspects:

COLUMN RAIL WEAR ADJUSTMENT
If honing several short workpieces for large quantities and for years, it may cause rail wearing clearly on one end. At this time, you can remove the column rail from the support base, and reverse the rail to be installed, then it can recover the running state of new rail.

It can also use the cycle method to avoid the wearing part. Because the linear bearings that we used are cycled by six even spaced ways, that is, every 60° even spaces a row of linear ball bearing (see Figure 4-3). Then you can rotate the column rail 20° relative to linear bearing, and can run at the no-wear column rail. If years later it emerged wear again, rotate the column rail 20° again can recover the good running state.

HONING INDICATOR ADJUSTMENT

With Power OFF, set light cutting pressure control dial to 2, and heavy cutting pressure control dial to 0. With zero point of honing indicator is at 6 o'clock position, needle should be at red line position.
If needle is to left of red line; honing is close to 0, stone pressure will immediately decrease, and rapidly slows down cutting.
If needle is just at red line; it can hone to 0 point under full load condition. Therefore it is necessary to adjust needle a bit to the red line.

1. If needle is not at red line, loosen hexagon socket screw and slide indicator up to maximum position, and then move it down. When needle moves one turn, continue to move it, until needle is at red line. Tighten screw to lock this position (see Figure 4-4).

2. Advance feed dial, when feed dial is released, needle should return to red line position. If needle does not return to red line position, or moves very slowly:
Remove honing indicator from machine.
Clean indicator shaft and check that indicator is working properly.
Then reinstall indicator and repeat step 2.

3. Clean and lubricate support assembly (see Figure 4-5).

PEDAL ADJUSTMENT

When the machine stops, check that the pedal can be adjusted in or out and up or down, for standing or sitting. When fully depressed, pedal must be at least 20mm from floor and not higher than 135mm from floor. To adjust, proceed as follows:

1. Loosen screw to adjust U bar in or out to a convenient operating position.

2. The crank arm should freely move to its lower position. This position can be achieved when the crank bar is in a line (see Figure 4-6). At this time, pedal must be at least 20mm from floor. If tall operators prefer, it can adjust up to 135mm. If inappropriate, adjust pedal height by turning self locking nuts on end of pedal link (see Figure 4-7).

ZERO SHUTOFF ADJUSTMENT

Operate machine and needle should be at "0" when honing cycle is complete.

1. Needle stops more than 5 division from "0" , adjust locking adjustment screws using 5/64" hex wretch as follows (see Figure 4-8):

a. To move shutoff point counterclockwise on dial, loosen upper screw and tighten lower screw.

b. To move shutoff point clockwise on dial, tighten upper screw and loosen lower screw.

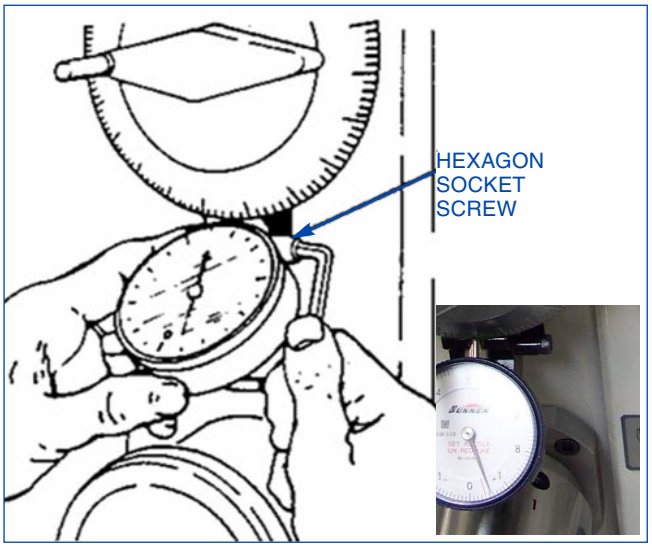


FIGURE 4-4, Feed Dial

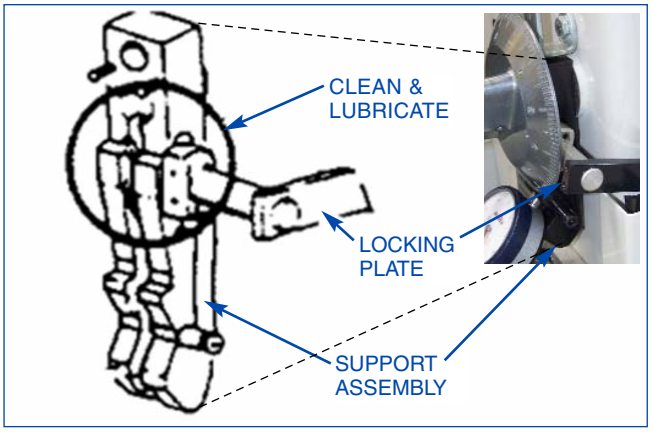


FIGURE 4-5, Support Assembly

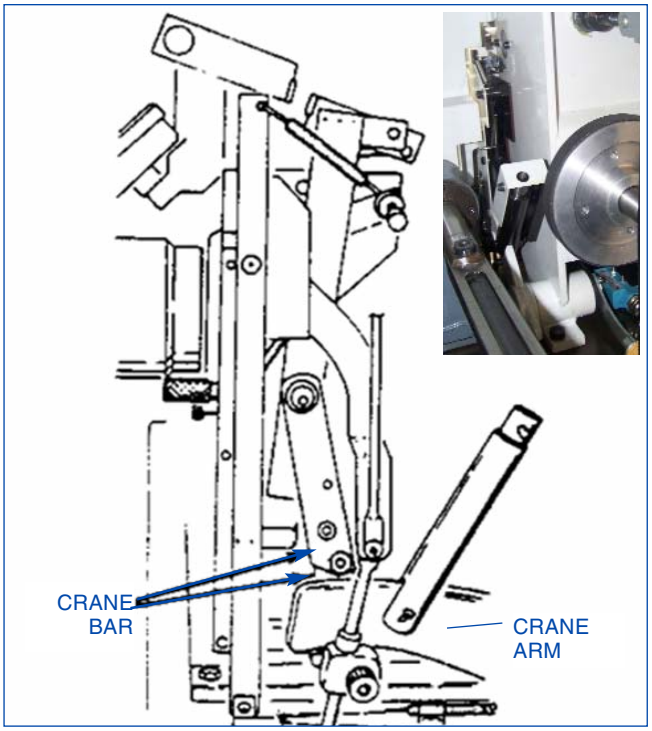


FIGURE 4-6, Crane Arm

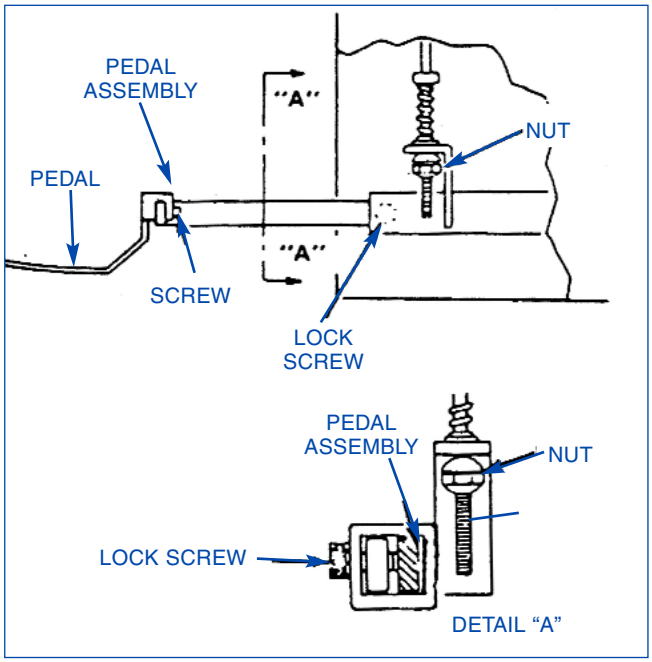


FIGURE 4-7, Pedal Assembly

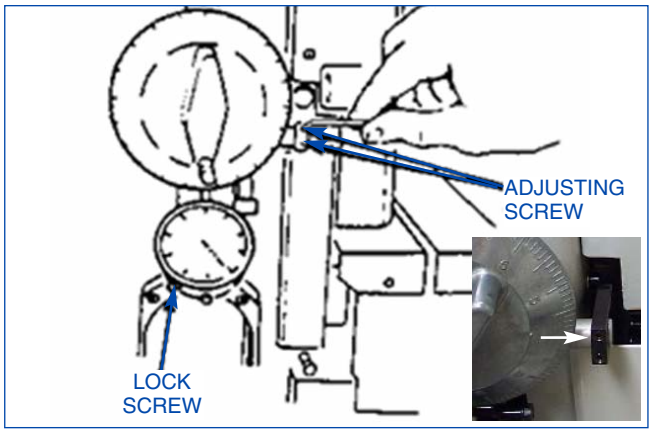


FIGURE 4-8, Support Assembly

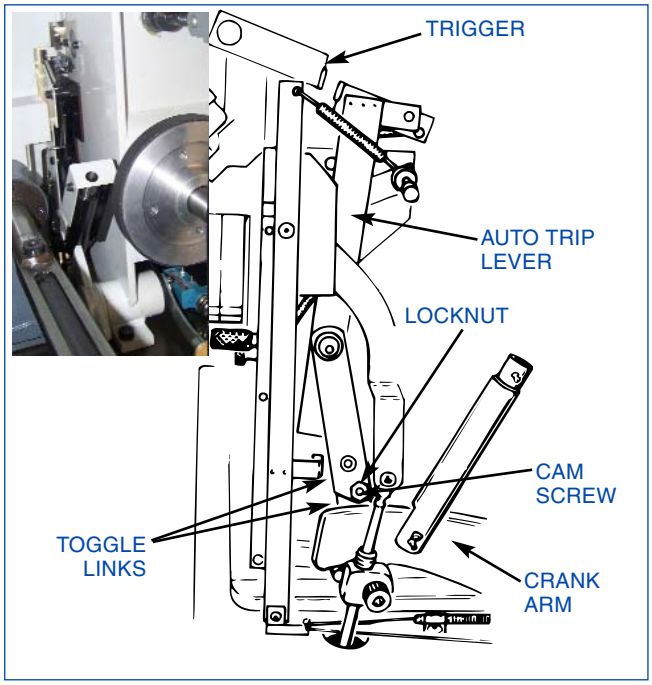


FIGURE 4-9, Automatic Cycle Stop Adjustment

2. Needle stops less than 5 divisions from "0". Loosen honing dial bezel clamp screw and rotate bezel until "0" agrees with shutoff point. Then tighten clamp screw.

AUTOMATIC CYCLE STOP ADJUSTMENT

If honing cycle stops before cycle is complete adjust as follows (see Figure 4-9):

1. Press E Stop pushbutton.
2. Turn cycle lockout fully counterclockwise.
3. Set heavy cutting pressure to "0".
4. Set light cutting pressure to “2".
5. Open cover of the machine.
6. Depress pedal and observe motion of cam screw as pedal pressure is released slightly. Cam screw should move approximately 0.4mm past center towards the front of the machine, adjust as follows: Loosen locknut using 3/8" wrench; rotate cam screw as required using 3/32" hex wrench, then tighten locknut.
7. Install a mandrel with stones into spindle nose, and place truing sleeve or workpiece on mandrel.
8. Fully depress pedal.
9. Turn feed dial until honing dial needle moves to between"1" and "2".
10. Release pedal. Pedal should raise but crank arm should remain held by toggle link. If crank arm does not stay down, repeat step f.
11. Adjust trigger adjustment screw so they are at equal depth in trigger using 5/64" hex wrench (refer to Figure 4-8).
12. Slowly rotate feed dial counterclockwise and observe honing dial needle and pedal motion.
13. If automatic cycle stop trips before needles reaches "0", adjust as follows. Loosen upper trigger adjustment screw and tighten lower trigger adjustment screw. Then return to step g and repeat steps.
14. If automatic cycle stop does not trip at all, adjust as follows. Loosen lower trigger adjusting screw and tighten upper trigger adjusting screw. Then return to step g and repeat steps until the requirements are met.
15. If automatic cycle stop trips before pedal is complete raise, adjust as follows. Loosen upper trigger adjusting screw and tighten lower trigger adjusting screw. Then repeat steps until requirements are met.

MOTOR DRIVE BELT REPLACEMENT

To inspect and replace Motor Drive Belt, proceed as follows (see Figure 4-10).

WARNING

Turn electrical power OFF at main buss box or main power source when performing any maintenance not requiring power.

1. Turn OFF all electrical power to machine.
2. Open Door on front of Machine and swing Drain Pipe up so Coolant Cart can be removed.
3. Remove four (4) Screws and remove cover from back of base.
4. Pull out the coolant cart from the back of machine.
5. Inspect Motor Drive Belt for signs of wear and/or damage. Replace as required.
6. Loosen Belt Tension Roller.
7. Remove Motor Drive Belts.
8. Install New Motor Drive Belt.
9 Adjust Belt Tension Roller and tighten.
10. Push Coolant Cart back under Machine base and reinstall cover, using four (4) screws.
11. At front of Machine and swing Drain Pipe down, then close and lock Door.
12. Turn ON power.

SPINDLE DRIVE BELT REPLACEMENT

To inspect and replace Spindle Drive Belt, proceed as follows (see Figure 4-11):

WARNING

Turn electrical power OFF at main buss box or main power source when performing any maintenance not requiring power.

1. Turn OFF all electrical power to machine.
2. Open top Door on rear of Machine.
3. Inspect Spindle Drive Belts for signs of wear or damage. Replace as required.
4. Loosen Tension Screw on side of Motor Plate (see Figure 4-12).
5. Remove two Bolts and Nuts securing Feed Arms as follows:

Insert 3/16 in. (5 mm) rod in Cross Hole in Feed Rod to keep Feed Rod from turning (refer to Figure 4-12).

Using 5/16 in. hex wrench, remove Screw and washer from Thrust Assembly.

6. Turn Feed Dial counterclockwise all the way until Adjusting Nut Assembly is clear of Feed Screw.

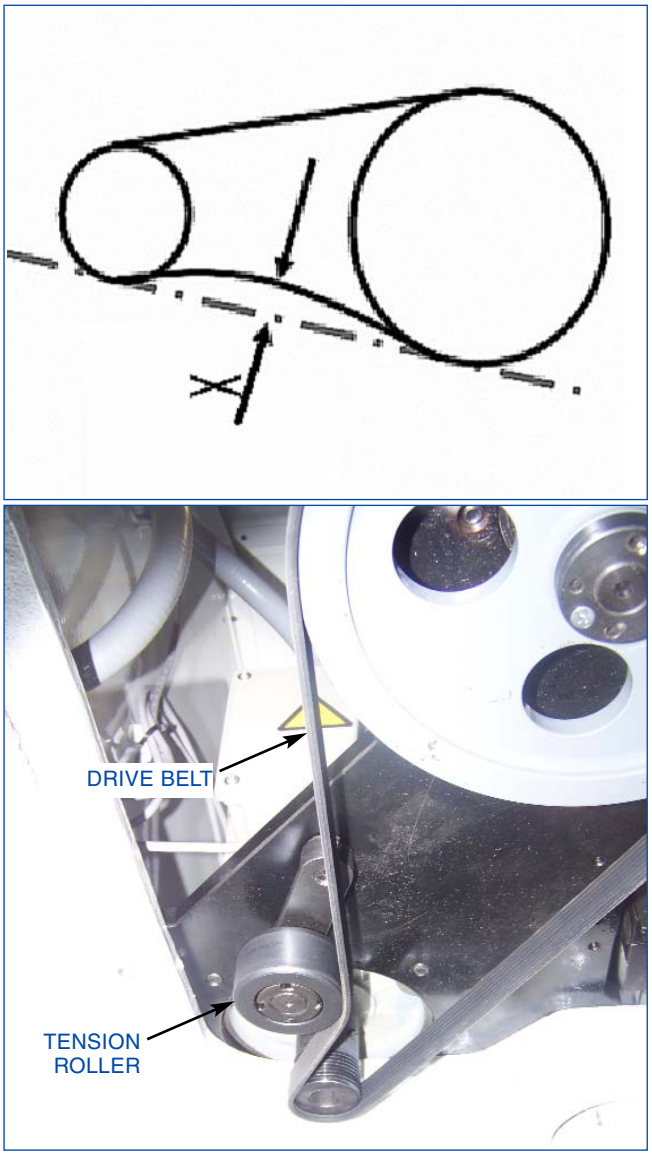


FIGURE 4-10, Motor V-Belt

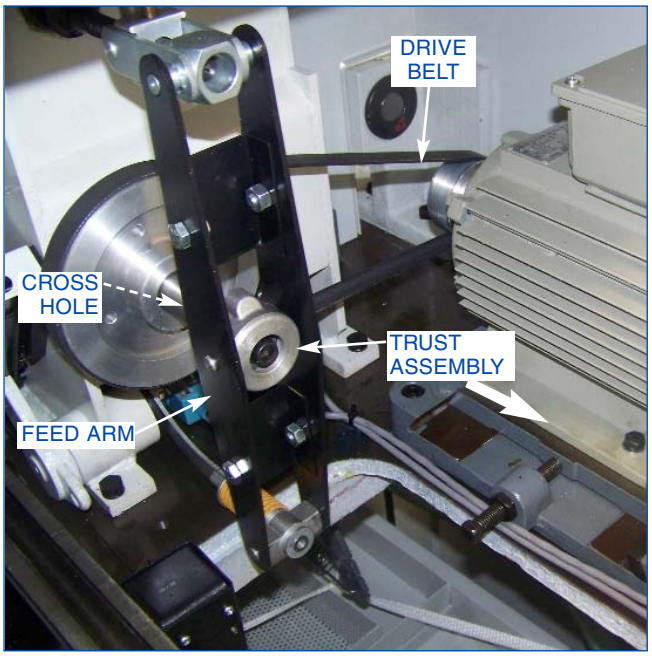


FIGURE 4-11, Spindle Drive Belt

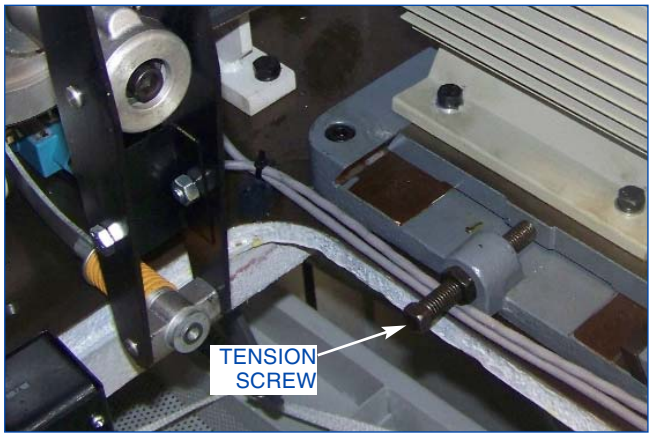


FIGURE 4-12, Tension Release Lever

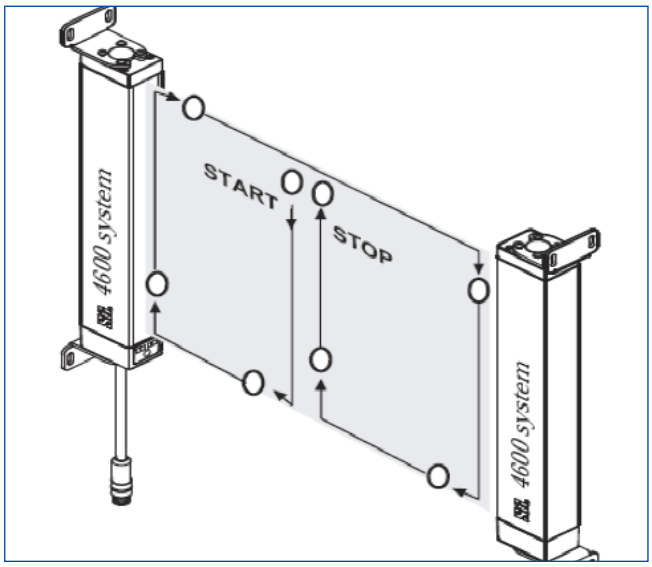


FIGURE 4-9, Light Curtain

7. Separate Arms and remove. Pull Feed Arm Assembly with Thrust Assembly off Feed Rod.

8. Remove old Spindle Drive Belt and install new Belt.

9. Ensure projection on Adjusting Nut Assembly is pointed upward; then, install Feed Arms and secure with Nuts and Bolts removed in step 5.

Reassemble Feed Arm Assembly to Feed Rod by engaging Adjusting Nut Assembly with Feed Screw and turning Feed Dial clockwise while inserting Feed Rod into Thrust Assembly. Projection on Adjusting Nut Assembly must point upward. Bearing retaining screws in Thrust Assembly must face back of machine head.

10. Adjust belt tension using Tension Screw.

11. Close and secure rear Door.

12. Turn ON power.

LIGHT CURTAIN FUNCTION TEST

(CE Machines Only) Check Light Curtain operation as follows (see Figure 4-13):

WARNING

The test outlined below must be performed at installation, according to employer's regular inspection program and after any maintenance, tooling change, setup, adjustment, or modification to Light Curtain System or the guarded machine. Where a guarded machine is used by multiple operators or shifts, it is suggested that the test be performed at each shift or operation change. Testing ensures that Light Curtain and machine control system work properly to stop the machine. Failure to test properly could result in injury to personnel.

1. Interrupt light curtain system with proper size test object (Test object size: 30 mm diameter). When using the test object, guide it through the detection zone as shown below. At least one individual beam indicator must be lit while test object is anywhere in detection zone.

2. Start machine. While machine is in motion, interrupt detection zone with test object. Machine should stop immediately. Never insert test object into dangerous parts of machine.

3. With machine at rest, interrupt detection zone with test object. Verify that machine will not start with test object in detection zone.

4. Verify that braking system is working properly. Machine must come to a quick controlled stop when light curtain is interrupted. Drive faults, spindle coasting and stroker coasting are unacceptable.

LIGHT CURTAIN CLEANING

Accumulation of oil, dirt and grease on the front filter of the light curtain transmitter and receiver can affect the system operation. Clean filters with a mild detergent or glass cleaner. Use a clean, soft, lint-free cloth. Painted light curtain surfaces may be cleaned with a mild de-greasing cleaner or detergent.

NOTES

SECTION 5
TROUBLESHOOTING

GENERAL

This section contains Troubleshooting information in table form which should be used when problems occur with the machine. The table lists problems encountered, possible causes, and solutions for the problems along with reference to the section of the manual where detailed instructions may be found to correct the problems.

OPERATIONAL TROUBLESHOOTING INDEX

For suggestions on correcting problems with bore conditions or with honing operation; consult Table 5-1.

TABLE 5-1, OPERATIONAL TROUBLESHOOTING INDEX

PROBLEM	PROBABLE CAUSE	SOLUTION	SEC.
Stone not cutting (Honing Dial Needle moves too slowly)	1. Stone Glazing	A. Dress stone	
		B. Increase cutting pressure	2
		C. Increase stroking speed	2
		D. Use softer stone	
		E. Check coolant *	4
	2. Stone Loading	A. Dress stone	
		B. Increase stroking speed	2
		C. Use softer stone	
		D. Use coarser stone	
		E. Check coolant *	4
Slow stock removal (Honing Dial Needle moves too slowly)	1. Improper spindle speed	A. Increase spindle speed	2
	2. Inadequate stone feed up	A. Increase cutting pressure	2
	3. Pressure flow	A. Adjust pressure	
	4. Improper stone	A. Use Softer Stone	
		B. Use coarser stone	
	5. Improper or diluted coolant *	A. Check coolant *	4
Poor stone life (Honing Dial Needle moves too fast)	1. Excessive stone feed up	A. Decrease cutting pressure	2
	2. Inadequate spindle speed	A. Increase spindle speed	2
	3. Excessive Pressure	A. Adjust pressure	
	4. Improper stone	A. Use harder stone	
		B. Use coarser stone	
	5. Improper or diluted coolant*	A. Check coolant *	4

*NOTE: Many honing problems, such as poor stone life, and rough finish, are caused by wrong coolant; insufficient coolant, dirty coolant, or contaminated coolant. Use ONLY clean, Sunnen Industrial Honing Oils or Water-Based Coolant. Make sure that coolant is neither diluted nor "cut" with other coolants. Keep solvents and cleaning fluids away from Machine.

TABLE 5-1, OPERATIONAL TROUBLESHOOTING INDEX (Cont'd)

PROBLEM	PROBABLE CAUSE	SOLUTION	SEC.
Bellmouth (Bore longer than 2/3 stone length)	1. Mandrel not trued 2. Short or unbalanced part 3. Improper stone 4. Improper stone length	A. True stone & shoes A. Shorten stroke length A. Use softer stone A. Shorten stone only slightly on each end	2
Bellmouth (Bore shorter than 2/3 stone length)	1. Mandrel not trued 2. Short or unbalanced part 3. Improper stone 4. Improper stone length	A. True stone & shoes A. Shorten stroke length A. Use softer stone A. Shorten stone & shoes equally to 1-1/2 times bore length	2
Barrel	1. Mandrel not trued 2. Improper stone length 3. Improper stone	A. True stone & shoes A. Use longer stone or shorten guide shoes on both ends B. Use mandrel with longer stone & shoes A. Use finer stone	2
Taper in Open Hole	1. Workpiece is not being reversed 2. Overstroke uneven 3. Mandrel not trued 4. Improper stroke 5. Stroker arm & spindle not ligned	A. Reverse workpiece on mandrel more often A. Readjust overstroke A. True stone & shoes A. Lengthen overstroke on tight end A. Align sroker arm & spindle	
Taper in Blind Hole	1. Improper stone length 2. Inadequate oil flow 3. Inadequate relief in blind hole	A. Shorten stone & shoes to 3/4 length of bore B. True stone & shoes frequently A. Adjust oil nozzle A. Provide sufficient relief B. Short stroke tight end C. Use hard tip stone	2
Out-Of-Round	1. Undersize honing tool 2. Mandrel not true 3. Workpiece flexing (thinwall) 4. Improper stone	A. Change honing tool A. True stone & shoes A. Decrease cutting pressure B. Use fixture which will not distort the workpiece A. Use softer stone	2 2
Waviness	1. Improper mandrel or stone length	A. Use mandrel with sufficient stone length to bridge waviness in bore	

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TABLE 5-1, OPERATIONAL TROUBLESHOOTING INDEX (Cont'd)

PROBLEM	PROBABLE CAUSE	SOLUTION	SEC.
Rainbow	1. Improper mandrel	A. Use L, BL or multi-stone mandrel (stone length should be 1-1/2 times bore length	
	2. Short or unbalanced part	A. Shorten overstroke	
	3. Improper stone	A. Use softer stone	
Rough Finish	1. Improper feed	A. Decrease cutting pressure	2
	2. Mandrel not trued	A. True stone & shoes to exact hole diameter	
	3. Stone loading	A. Use softer stone	
	4. Improper stone	A. Use finer stone	
	5. Improper or diluted coolant *	A. Check coolant *	4
	6. Soft or exotic materials	A. Use bronze mandrel or bronze shoes	
Scratches in Bore (Random)	1. Improper feed	A. Decrease cutting pressure	2
	2. Stone loading	A. Use softer stone	
	3. Improper stone	A. Use finer stone	
		B. Use softer stone	
	4. Improper mandrel	A. If using hard steel mandrel, change to soft steel mandrel; if using soft steel mandrel, change to bronze mandrel	
	5. Improper or diluted coolant *	A. Check coolant *	4

*NOTE: Many honing problems, such as poor stone life, and rough finish, are caused by wrong coolant; insufficient coolant, dirty coolant, or contaminated coolant. Use ONLY clean, Sunnen Industrial Honing Oils or Water-Based Coolant. Make sure that coolant is neither diluted nor "cut" with other coolants. Keep solvents and cleaning fluids away from Machine.

GENERAL TROUBLESHOOTING INDEX

For suggestions on correcting problems due to improper machine setup or adjustment; consult Table 5-2.

TABLE 5-2, GENERAL TROUBLESHOOTING INDEX

PROBLEM	PROBABLE CAUSE	SOLUTION	SEC.
AUTOMATIC SIZE CONTROL Hone shuts off when Pedal is released	1. Cycle Lockout improperly set	A. Turn Cycle Lockout fully counterclockwise	2
	2. Improperly set Selector Switch	A. Adjust switch	2
	3. Improperly set Sensing Tip	A. Adjust Sensing Tip	2
	6. Automatic Cycle Stop improperly set	A. Adjust	4
	7. Insufficient or improperly set Feed	A. Adjust	4
	8. Electrical problem	A. Contact local Sunnen Field Service Technician	
Hone does not shut off when part is to size	1. Switch improperly set	A. Adjust switch	2
Pedal does not move down	1. Pedal travel improperly set	A. Adjust Pedal travel	4
Pedal moves too fast up or down	1. Pedal travel improperly set	A. Adjust Pedal travel	4
Pedal moves slowly or does not complete travel	1. Pedal travel improperly set	A. Adjust Pedal travel	4
Honing cycle stops as Pedal moves back up	1. Cycle Lockout improperly set	A. Turn Cycle Lockout fully counterclockwise	2
	2. Pedal travel improperly set	A. Adjust Pedal travel	4
Power will not come on when POWER ON is pressed	1. Machine Door is not closed	A. Make sure all doors are closed	
Cycle won't start	1. Work Area Cover or machine Door is not closed	A. Make sure all covers and guards are in place	
	2. Previous cycle was interrupted	A. Work Area Cover must be lifted between each honing cycle to reset the machine	

APPENDIX A
MACHINE ELECTRICAL PRINCIPLES AND NOTES

WORKING ENVIRONMENT

The installing environment for the inverter has direct influence on normal use of inverter function and inverter life. Therefore the working environment must conform to the following conditions:

1. Power requirements: 380V ± 10% 50Hz or 230V+/- 10% (3PH), Load capacity > 40A / XXA, Grounding resistance<10 .
2. Temperature: - 10~+40 C.
3. Relative humidity: less than 95%
4. Keep coolant out of the electrical enclosure.
5. To prevent dust, cotton fiber, metal dust and other wastes from getting into the electrical enclosure.
6. Be far away from the caustic gas, liquid, radioactive substances and combustible mass.
7. To prevent electromagnetic interference, and to reduce vibration.
8. To avoid rain drenching and direct sunshine.

ELECTRICAL CIRCUIT

1. Major loop:
   The spindle loop is composed of QS, 1KM, INV1, M1.
   The stroke loop is composed of QS, 1KM, INV2,M2.
   The coolant loop is composed of QS, 3KM, FR, M3.
2. Control loop: It is composed of the circuit that is supplied by the secondary “8-9” end of the transformer.
3. Auxiliary loop: It is composed of the circuit that is supplied by the secondary “4-5”, “6-7” end of the transformer.

INSTALLING

1. Open the door of electrical enclosure, and visually check whether the components are in good condition and whether the connected wires are loose.
2. Open the covers to check whether the wires connected to the motor, pump, pedal, safety switch, limit switch and the inverter display panel are good.
3. After the above surface check, connect A, B, C three-phases separately to terminal L1, L2, L3 of the XT3 power-supply block.
4. Connect electrical grounding cord to the PE terminal of the XT3 block.

NOTE: No connection to the center line!

WORKING PRINCIPLES

1. Close the master power switch QS, and light XL1 is lit to indicate that the electrical enclosure is connected to the power source. At the same time, the cooling fans F1, F2 of the inverter motor begin rotating, and the fan F3 on the side of the enclosure also rotates. Use a piece of paper test to see if F1 and F2 are taken the air while F3 drains the air. Through 6FU, SA1, SA6 make 1KM have electricity, and add 3-phase power source to the terminal R.S.T of the inverter, now the inverter is displayed.
2. Press “Reset” button SB1, then 2KM has electricity, YA electro-magnet pulls in to make the pedal reset.
3. Make the stroke carriage away from the front and back position, to make sure that SA4 and SA5 are closed.
4. Press “Power ON” button SB2, then 3KM has electricity and locked, pump motor M3 is working. Check the rotation of the motor, if rotation is incorrect, reverse any two wires of A, B, or C.
5. Jog operation: Press and hold Jog button SB4, then 6K has electricity, and ends”4-9” are closed. INV2 is working and make M2 have electricity, then the stroke carriage slides back and forth at the set jog speed. Release the jog button to stop sliding.
6. Manual stroke operation: Turn SA3 to “Manual”. Depress pedal SA2, and “1-3” ends of SA2 are closed, 4K has electricity, and to make “2-9” ends of INV1 closed. INV1 is working and make M1 have electricity, then spindle rotates.
7. Power stroke operation: Turn SA3 to “Auto”. Depress pedal SA2, and “1-3” ends of SA2 are closed, 5K has electricity, and to make “2-9” ends of INV2 closed. INV2 is working and make M2 have electricity, then the stroke carriage slides back and forth at the set jog speed. This type of cycle running completes the honing operation.
8. When honing is completed, the zero shutoff mechanism works to make “1-3” ends of SA2 open, and 4K or 5K lose electricity, INV1, INV2 stops running, and the spindle and stroke are both stopped.
9. When temporarily not running, press “Power OFF” button SB3, then 3KM loses electricity, pump motor M3 stops, and light XL2 is black out. Now jog operation, manual stroke operation and power stroke operation have no effect.
10. When stopping honing for a short time, you can also turn SA3 to “Blank”.

NOTES

1. When the master power switch QS is closed, but the inverter has no display, then it is possible that the back cover is not closed and the safety switch SA6 is open.

2. When press “Power ON” button SB2, there is no control power and light XL2 is not lit. Then the carriage could be at the front or back limit position, and the limit switch SA4 or SA5 is open, so the power is not on. At this time, only to move the carriage away from the two limit positions, can eliminate the trouble. If the carriage is not at the front or back limit position, but the power remains off, then it is possibly caused by the pedal switch SA2 is not being reset, and “1-3” ends of SA2 are open. Only to press reset button SB1, can turn on the power normally. The troubles mentioned above are caused by the effect of limit protection switch and back cover protection switch, and this is not the electrical fault. However, setting protection switch is necessary for protecting personnel and machine safety.

WARNING

For safety, when the inverter has a fault, it should be checked and repaired by maintenance personnel. The inverter parameters are locked by design, so the customer cannot change them by himself, otherwise damage to the machine can occur. If the customer has special demands and needs to change the parameters, please contact Sunnen Products Company, we will supply all support, don't change them by yourself.

INVERTER PROTECTION FUNCTION

The inverter has several protection functions itself. This can avoid certain loss of some operations or caused by misuse. When the protection function is in effect, it can automatically cut off the output of the inverter, and displays the type of protection functions. For the operators convenience the table below provides some possible causes according to the displayed information and eliminate the trouble.

The protection functions shown in Table A-1, are related to possible error from the honing process, and this is not a fault of the inverter. The operator can turn master power switch off and on to clear the fault, however, the operator must record the situation, including the displayed information, the condition of the process, and then turn off the machine to analyze the cause and eliminate the fault. Then turn the machine on to restart working.

WIRING DIAGRAM:

1. Introduction of several components:
   - a）Master power switch QS
   - b）E-Stop switch SA1
   - c）Power ON button SB2
   - d）Power OFF button SB3
   - e）Reset button SB1
   - f）Stroke jog button SB4

2. Electrical Diagrams: Placed in the door files under the base.

TABLE A-1, Protection Functions

PROTECTION TYPE	DISPLAYED INFORMATION	SOLUTIONS
1. Overcurrent Protection	OC1,OC3	Decrease cutting pressure; Check if the out power is lower.
2. Overvoltage Protection	OU1,OU3	Decrease cutting pressure; Decrease load.
3. Overheat Protection	OH	Check around temperature.
4. Too Much Disturb	CPU	Check if there is a disturb source.

APPENDIX B
COOLANT FLOW DIAGRAM

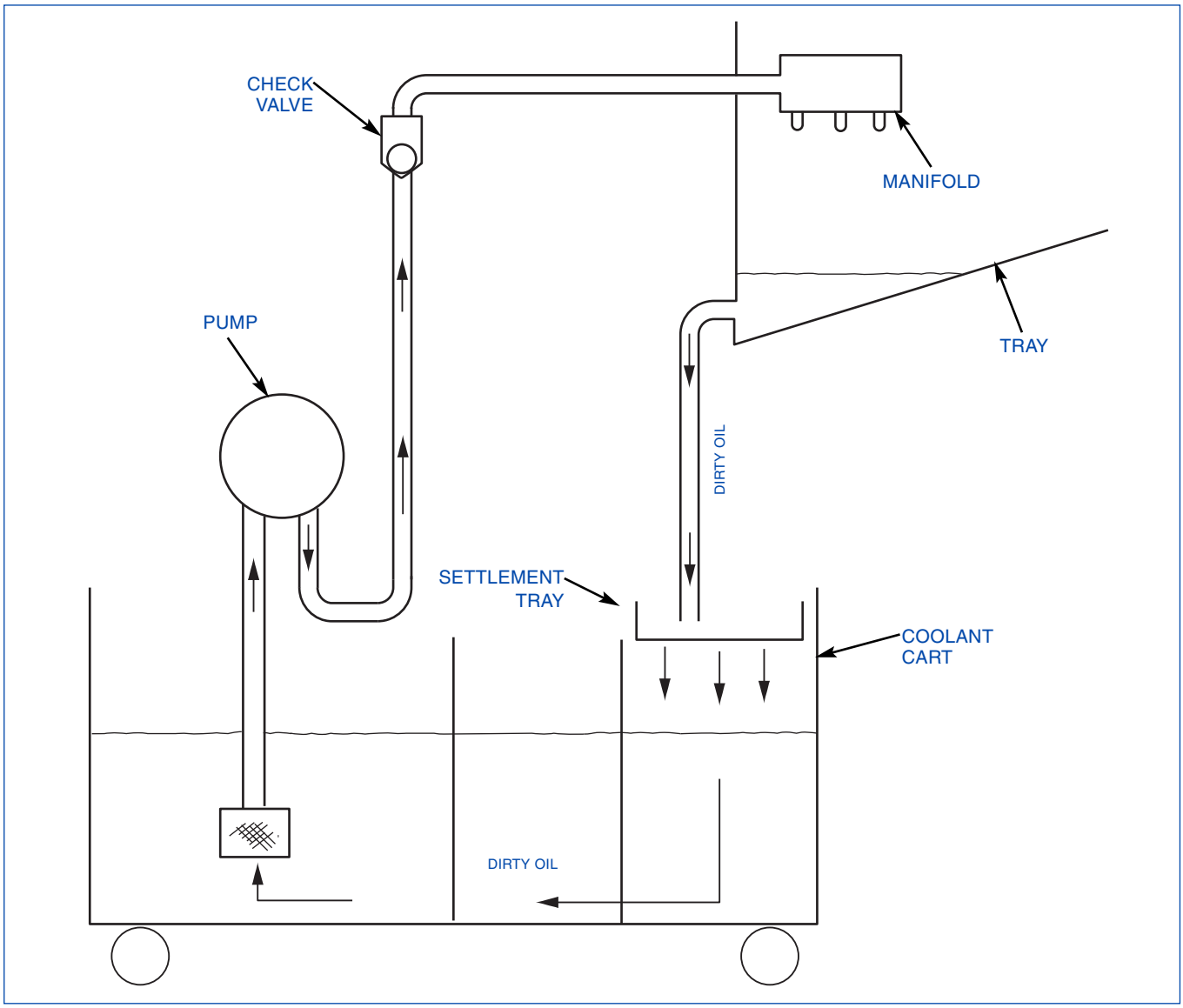


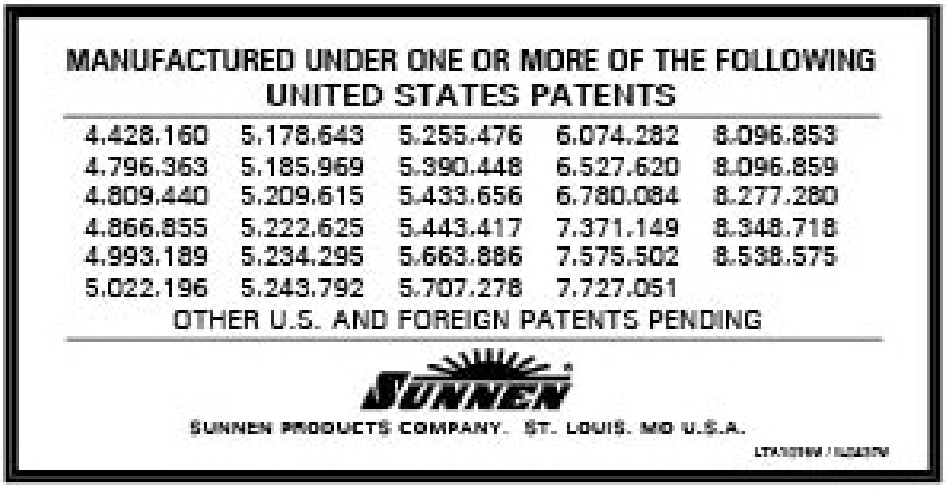
FIGURE B-1, Coolant Flow Diagram

NOTES

NOTES

NOTES

Like any machinery, this equipment may be dangerous if used improperly. Be sure to read and follow instructions for operation of equipment.



WARNING

An Arc Flash Hazard Exists. Follow safe work practices and wear appropriate Personal Protective Equipment. Follow proper lockout/tagout procedures. ***Failure to comply can result in death or injury.***

FRACTION / DECIMAL / MILLIMETER EQUIVALENTS CHART

INCH FRACTION	INCH DECIMAL	MILLIMETER	INCH FRACTION	INCH DECIMAL	MILLIMETER	INCH FRACTION	INCH DECIMAL	MILLIMETER
. . . .	.003937	0,1000	9/32	.281250	7,1438	21/32	.656250	16,6688
. . . .	.007874	0,2000	19/64	.296875	7,5406	. . . .	.669291	17,0000
. . . .	.011811	0,3000	5/16	.312500	7,9375	43/64	.671875	17,0656
1/64	.015625	0,3969	. . . .	.314961	8,0000	11/16	.687500	17,4625
. . . .	.015748	0,4000	21/64	.328125	8,3344	45/64	.703125	17,8594
. . . .	.019685	0,5000	11/32	.343750	8,7313	. . . .	.708661	18,0000
. . . .	.023622	0,6000	. . . .	.354331	9,0000	23/32	.718750	18,2563
. . . .	.027559	0,7000	23/64	.359375	9,1281	47/64	.734375	18,6531
1/32	.031250	0,7938	3/8	.375000	9,5250	. . . .	.748031	19,0000
. . . .	.031496	0,8000	25/64	.390625	9,9219	3/4	.750000	19,0500
. . . .	.035433	0,9000	. . . .	.393701	10,0000	49/64	.765625	19,4469
. . . .	.039370	1,0000	13/32	.406250	10,3188	25/32	.781250	19,8438
3/64	.046875	1,1906	27/64	.421875	10,7156	. . . .	.787402	20,0000
1/16	.062500	1,5875	. . . .	.433071	11,0000	51/64	.796875	20,2406
5/64	.078125	1,9844	7/16	.437500	11,1125	13/16	.812500	20,6375
. . . .	.078740	2,0000	29/64	.453125	11,5094	. . . .	.826772	21,0000
3/32	.093750	2,3813	15/32	.468750	11,9063	53/64	.828125	21,0344
7/64	.109375	2,7781	. . . .	.472441	12,0000	27/32	.843750	21,4313
. . . .	.118110	3,0000	31/64	.484375	12,3031	55/64	.859375	21,8281
1/8	.125000	3,1750	1/2	.500000	12,7000	. . . .	.866142	22,0000
9/64	.140625	3,5719	. . . .	.511811	13,0000	7/8	.875000	22,2250
5/32	.156250	3,9688	33/64	.515625	13,0969	57/64	.890625	22,6219
. . . .	.157480	4,0000	17/32	.531250	13,4938	. . . .	.905512	23,0000
11/64	.171875	4,3656	35/64	.546875	13,8906	29/32	.906250	23,0188
3/16	.187500	4,7625	. . . .	.551181	14,0000	59/64	.921875	23,4156
. . . .	.196850	5,0000	9/16	.562500	14,2875	15/16	.937500	23,8125
13/64	.203125	5,1594	37/64	.578125	14,6844	. . . .	.944882	24,0000
7/32	.218750	5,5563	. . . .	.590551	15,0000	61/64	.953125	24,2094
15/64	.234375	5,9531	19/32	.593750	15,0813	31/32	.968750	24,6063
. . . .	.236220	6,0000	39/64	.609375	15,4781	. . . .	.984252	25,0000
1/4	.250000	6,3500	5/8	.625000	15,8750	63/64	.984375	25,0031
17/64	.265625	6,7469	. . . .	.629921	16,0000	1	1.000000	25,4000
. . . .	.275591	7,0000	41/64	.640625	16,2719	1-1/16	1.062500	26,9880

FORMULAS:

MULTIPLY		BY		TO GET
INCHES (in)	x	25.4	=	MILLIMETERS (mm)
FEET (ft)	x	0.3048	=	METERS (m)

MULTIPLY		BY		TO GET
MILLIMETERS (mm)	x	0.03937	=	INCHES (in)
METERS (m)	x	3.281	=	FEET (ft)

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